FINAL

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Prepared for

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Prepared by

ch2m

Contents

Figures

Acronyms and Abbreviations

µg/L	micrograms per liter
AEP	Appalachian Electric Power
AS	air sparge
BTAG	Biological Technical Assistance Group
CAH	chlorinated aliphatic hydrocarbon
CCV	continuing calibration verifications
COC	constituent of concern
COV	coefficient of variation
EB	equipment blank
ESL	ecological screening level
facility	Union Carbide Corporation Institute facility
GWPMR	groundwater performance monitoring report
GWSL	groundwater screening level
HPH	high-purity hydrocarbon
ICVS	initial calibration verification standard
IRM	interim remedial measure
ISCO	in situ chemical oxidation
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
MCL	maximum contaminant level
MS/MSD	matrix spike/matrix spike duplicate
PARCC	precision, accuracy, representativeness, completeness, and comparability (PARCC
PCE	tetrachloroethene
PHC	petroleum hydrocarbon
PMP	*Sitewide Groundwater Performance Monitoring Plan*
PTO	Private Trucking Operations
QA/QC	quality assurance/quality control (QA/QC)
RL	reporting limit
RPD	relative percent difference
RRF	relative response factor
RSL	regional screening level
SVE	soil vapor extraction

SVOC	semivolatile organic compound
UCC	Union Carbide Corporation
USEPA	U.S. Environmental Protection Agency
VI	vapor intrusion
VOC	volatile organic compound
WVSU	West Virginia State University
WWTU	wastewater treatment unit

Introduction

This groundwater performance monitoring report (GWPMR) has been prepared for the Union Carbide Corporation (UCC) Institute facility (hereafter referred to as the facility) in Institute, West Virginia (**Figure 1**). This GWPMR presents the data and findings from the annual groundwater monitoring event in October 2015. This event was conducted in accordance with the revised *Sitewide Groundwater Performance Monitoring Plan* (PMP) (CH2M 2014). The revised PMP was approved in EPA email correspondence dated May 20, 2015 and replaced the original PMP (CH2M 2011a).

1.1 Objective

The objective of this GWPMR is to summarize and evaluate the results of systematic monitoring and evaluation of groundwater conditions at the facility. The groundwater monitoring data were evaluated in accordance with the following three performance monitoring standards outlined in the PMP:

- **Onsite Containment** – Structured to monitor groundwater adjacent to property boundaries and the Kanawha River to evaluate potential offsite migration of constituents of concern (COCs).
- **Plume Stability** - Structured to verify concentrations of groundwater COCs onsite are stable or decreasing in magnitude (i.e., not migrating).
- **Reduction in Constituent Mass** – Structured to ensure groundwater quality continues to improve over time as measured by a reduction in the COC mass dissolved in groundwater at the main chemical plant.

Additional information related to the performance monitoring standards is included in the original and revised PMPs (CH2M 2011a and 2014).

1.2 Interim Remedial Measures Update

Since the last GWPMR, several interim remedial measures (IRMs) have been implemented or continued at the facility to reduce constituent concentrations in soil and groundwater, prevent migration of groundwater with constituent concentrations above site-specific criteria to adjacent offsite properties or the Kanawha River, and accelerate the reduction of constituent mass in "hot spot" areas. Several historical IRMs are summarized in the *2011 Groundwater Performance Monitoring Report* (CH2M 2011b).

As of April 2016, the following IRMs are ongoing or planned at the facility (see **Figure 2** for locations):

- **High-Purity Hydrocarbon (HPH) Area –** An air sparge (AS) and soil vapor extraction (SVE) system was installed and began operation in March 2011. The SVE wells are equipped with pneumatic pumps to dewater the wells and facilitate vapor recovery. In October 2014, the AS and SVE systems were shut down over the winter to prevent the aboveground groundwater extraction lines from freezing. The shutdown period also allowed the project team to assess changes in volatile organic compound (VOC) groundwater concentrations while the system was not operating.

  The dewatering pumps were restarted in June 2015, and SVE and AS operations resumed in July and August 2015, respectively. The dewatering pumps and SVE system were again shut down on October 30, 2015, for the winter. The AS wells remain in operation at low flow rates typical of biosparge systems. The system will be operated in this manner over the 2016 winter months.

  Performance groundwater samples were collected in February, May, August, and October 2015 from several site wells to monitor VOC trends in response to changes in operation of the HPH remediation system. VOC concentrations exhibited an overall decreasing concentration trend within the deep aquifer (TW-63B and TW-68) and an increasing concentration trend within the monitoring well screened within the silt/clay aquitard (TW-63A). Groundwater performance monitoring will be performed quarterly in 2016. The data collected in the first quarter of 2016 will be used to evaluate any changes in second quarter operations.

- **Tank 1010 Area** – Two in situ chemical oxidation (ISCO) injection events have occurred in the Tank 1010 benzene source area. The first injection took place in late 2014 using CoolOx™, which was injected into the subsurface via direct-push methods. Following evaluation of the performance monitoring data collected 30 and 90 days after the 2014 injection, the project team decided to complete additional soil sampling to support design of a second, more focused application of the CoolOx™. The resulting design had a reduced target injection area and depth interval from that completed in 2014, and the injection boring spacing was slightly reduced. In December 2015, CoolOx™ was injected across an approximate 1,000-square-foot area from 10 to 20 feet below ground surface. Approximately 2,100 gallons of the reagent were injected into 90 borings spaced between 3 and 4 feet apart. Post-injection sampling was completed in March 2016 to assess changes in soil and groundwater concentrations from the pre-injection levels. Results will be used to determine if additional injection events are necessary or if alternate remedial methods should be considered.
- **Area 3 (Former Fluorocarbon Plant)** – Several soil and groundwater source areas associated with the former Fluorocarbon Plant were delineated in 2014. Remedial alternatives were evaluated and aerobic cometabolic biodegradation via cometabolite-enhanced biosparging was selected for active groundwater remediation. A biosparge system with SoyGold™ 5000 amendments was installed at two sub-areas of the site in 2015 and began operating in late 2015. The system will be expanded in 2016 to include two additional sub-areas. Performance groundwater sampling will be completed during and after remedy implementation to evaluate if stable/decreasing concentration trends are occurring. If statistically significant increasing concentrations of COCs are observed in monitoring wells, a targeted soil remedy may be implemented for source area soils.
- **SWMU 11 (Chemfix Area)** – This location was used for treatment and disposal of sludge from the wastewater treatment unit (WWTU) that was constructed in the 1960s. The area was capped in the early 1980s, but it was determined in 2013 that this cover did not meet cover thickness and permeability requirements for a final remedy. An additional 12 inches of cover material (6 inches of clay and 6 inches of topsoil) were added to the existing soil cover in late 2013. A construction completion report was prepared and will be submitted with the Corrective Measures Proposal in 2016.

Groundwater Performance Monitoring Field Activities

2.1 Water Level Measurements

Synoptic water level measurements were collected before sampling the monitoring wells during the October 2015 annual groundwater sampling event (**Table 1** and **Figure 3**). The monitoring wells were gauged using a handheld electronic water level meter.

Water level measurements were collected October 13-16, 2015, from 52 of 53 monitoring wells in the main plant area and 14 of 18 monitoring wells in the WWTU area. A water level measurement was inadvertently not collected from TW-64 in the main chemical plant. In the WWTU area, wells W-1A and W-14A were inadvertently gauged rather than wells W-1B and W-14, respectively, which are specified for gauging in the PMP (CH2M 2014). In addition, WWTU wells W-2A and W-3A had obstructions in the wells that prevented measuring of the water level. The lack of measurements in these wells did not affect the interpretation of groundwater data at the facility.

2.2 Groundwater Sampling

With the exception of wells TW-64 and W-2A, groundwater samples were collected from the all the wells in the main chemical plant and WWTU monitoring well program in October 2015 (**Table 1** and **Figure 3**). During the sampling event, TW-64 was inadvertently not sampled because the field team believed there to be an obstruction in the well. After further inquiry, TW-64 was found intact and was sampled in February 2016. Well W-2A was not sampled due to a pump stuck inside the well that could not be removed. The pump in well W-2A will be removed prior to the 2016 annual PMP monitoring event in conjunction with other scheduled well improvements at the facility.

The groundwater samples were collected using the low-flow groundwater sampling technique described in the standard operating procedures included in the PMP (CH2M 2014). The main plant groundwater samples were analyzed for the list of VOCs identified in the revised PMP using U.S. Environmental Protection Agency (USEPA) Method 8260B. Groundwater samples also were collected from a subset of nine main chemical plant wells for targeted semivolatile organic compounds (SVOCs) using USEPA Method 8270UL. Six WWTU wells were sampled for a targeted list of VOCs, SVOCs, and metals using USEPA Methods 8260B, 8270UL, and 8210, respectively.

Groundwater Performance Monitoring Results and Evaluation

3.1 Groundwater Elevation Results

Groundwater elevation data collected during the October 2015 groundwater monitoring event indicate groundwater generally flows south toward the Kanawha River in the main chemical plant area, with the groundwater gradient becoming steeper adjacent to the river. In the WWTU area, groundwater generally flows to the west-southwest. The October 2015 elevation results are similar to those collected during previous groundwater monitoring events (**Table 2** and **Figure 4**).

3.2 Groundwater Sampling Results

A summary of groundwater analytical data collected during the October 2015 annual sampling event is presented in **Table A-1** in **Appendix A**. The complete laboratory analytical reports are presented in **Appendix B** (provided electronically on CD), and the laboratory data quality evaluation report is presented in **Appendix C**.

3.2.1 Data Quality Evaluation Summary

The October 2015 groundwater data were validated using the precision, accuracy, representativeness, completeness, and comparability (PARCC parameter) criteria outlined in the *Program Quality Assurance Project Plan* (CH2M 2012). The laboratory reports and comprehensive data validation reports are provided in **Appendixes B** and **C**, respectively. The following findings were noted:

- J-qualified results are treated as detects at the reported concentration; however, the data user should understand the results are "estimated". The J-qualified results for this data set were the result of quality assurance/quality control (QA/QC) exceedances in initial calibration verification standards (ICVSs), continuing calibration verifications (CCV), field duplicate relative percent difference (RPD), matrix spike/matrix spike duplicate (MS/MSD) RPDs, and/or surrogate issues. J-qualified data are fully available for use and do not present a significant negative impact on project decisions.

- UJ-qualified results are treated as non-detects at the reporting limit; however, the reporting limits are estimated and may or may not represent the actual limit necessary to accurately and precisely measure the analyte in the sample. UJ-qualified data were the result of QA/QC exceedances in the ICVSs and/or CCVs. UJ-qualified data are fully available for use and do not present a significant negative impact on project decisions.

- K-qualified results are treated as detects at the reported concentration; however, the reported concentrations are considered "estimated" with a high bias. K-qualified data were the result of QA/QC exceedances in the MSD. K-qualified data are fully available for use and do not present a significant negative impact on project decisions.

- L-qualified results are treated as detects at the reported concentration; however, the reported concentrations are considered "estimated" with a low bias. L-qualified data were the result of QA/QC exceedances in the calibration relative response factors (RRFs), laboratory control sample/laboratory control sample duplicates (LCS/LCSDs), MS/MSDs, and/or surrogates. L-qualified data are fully available for use and do not present a significant negative impact on project decisions.

- UL-qualified results are treated as non-detects at the reporting limit; however, the reporting limit is considered "estimated" with a low bias. UL-qualified data were the result of QA/QC exceedances in the calibration RRFs, LCS/LCSDs, MS/MSDs, and/or surrogates. UL-qualified data are fully available for use and do not present a significant negative impact on project decisions.

- B-qualified results indicate that a compound was detected in an equipment blank (EB), trip blank, or method blank. Several compounds were detected at concentrations greater than the reporting limit (RL) in several EBs. The data were qualified as estimated non-detects and flagged "B" when the associated sample concentrations were less than five times the blank concentrations. B-qualified data present a negative impact on project decisions. An uncertainty lies with the concentration, especially if the compound detected has not been noted during previous sampling events. Tetrachloroethene (PCE) was detected slightly above the RL of 1 microgram per liter (µg/L) in samples W5A-GW-102915 and W14-GW-102815 due to cross over contamination. PCE was not detected at these sample locations during the previous sampling event (November 2014). Therefore, B-qualified data were replaced by proxy non-detect values in data evaluation calculations included in this GWPMR.

- As noted in the PMP (CH2M 2014) approved by the EPA, several analytes cannot be qualified within current laboratory RLs to meet screening level criteria. Although the laboratory RL is slightly above some of the screening levels, the objectives of the PMP will still be achieved.

Overall, data quality is acceptable and the results may be used in project decisions taking into consideration the potential biases and validation flags applied to the data set.

3.3 Performance Monitoring Standard Evaluation

Monitoring wells in the PMP well network are categorized into four main categories — Theissen wells, sentinel wells, perimeter wells, and "other wells" — to facilitate evaluation of the groundwater data (CH2M 2014). The monitoring wells and their intended purposes are listed in **Table 1** and illustrated on **Figure 3**. Performance monitoring focuses on achieving three performance standards: onsite containment, plume stability, and reduction in contaminant mass.

The evaluation of plume stability and reduction in contaminant mass at the main plant focuses on four key COC groups that were established in the PMP to facilitate evaluation of the groundwater performance monitoring standards and streamline monitoring of plume dynamics, specifically the change in the dissolved constituent mass of the COC groups over time (CH2M 2011a). Collectively, the COC groups represent most of the COC mass in groundwater at the main chemical plant. The four key main chemical plant groundwater COC groups are chlorinated aliphatic hydrocarbons (CAHs), petroleum hydrocarbons (PHCs), carbon tetrachloride, and chloroform. At the WWTU, plume stability is assessed based on evaluation of all of the selected COCs while reduction in mass is not assessed due to the low concentrations at that unit.

3.3.1 Performance Standard 1: Onsite Containment

This performance standard is a measure of whether COCs are contained on the site, and if not, whether exposures have been controlled. The evaluation process for the onsite containment groundwater performance standard includes comparing groundwater COCs in perimeter monitoring wells to risk-based criteria. The perimeter monitoring well network adjacent to property boundaries and the Kanawha River is summarized in **Table 3**.

Table D-1 in **Appendix D** presents groundwater analytical results at perimeter monitoring wells along property boundaries screened against the USEPA maximum contaminant levels (MCLs) (USEPA 2009a), or tap water regional screening levels (RSLs) (USEPA 2015) if no MCL exists. **Table D-2** in **Appendix D** presents groundwater analytical results for monitoring wells adjacent to the Kanawha River screened against the site-specific groundwater screening levels (GWSLs) protective of Kanawha River exposure pathways for both human and ecological receptors, or USEPA Biological Technical Assistance Group (BTAG) Region 3 ecological screening levels (ESLs) (USEPA 2006).

Six of nine property boundary monitoring wells exceeded the MCLs/RSLs, and five of 15 river perimeter monitoring wells exceeded the GWSLs/ESLs. WWTU well W-2A could not be assessed because no sample was collected in 2015 due to a pump stuck in the well.

The results indicate that 1,4-dioxane and 1,2-dichloroethane at perimeter monitoring wells TW-60A, TW-60B, or VW-15B are present along the western boundary adjacent to the Appalachian Electric Power (AEP) site property. In addition, results indicate that 1,4-dioxane and 1,1-dichloroethane found in monitoring wells TW-65A and TW-65B are present along the eastern property boundary adjacent West Virginia State University (WVSU) property. **Table 4** summarizes where exceedances occurred, indicates the offsite pathway, and notes if a focused corrective action is underway or whether an offsite environmental covenant is planned. Investigation work at the AEP and WVSU properties has been completed and reported under separate cover.

The onsite containment groundwater performance standard is met if COC concentrations are below the applicable risk-based criteria in perimeter wells or if potential exposures are controlled if concentrations exceed criteria. Potential offsite migration of groundwater constituent plumes along property boundaries and the Kanawha River has been recognized.

3.3.2 Performance Standard 2: Plume Stability

This performance standard is a measure of the potential for further migration of COCs as well as a measure of changes in water quality over time. The groundwater performance evaluation for plume stability is based on monotonic trend analysis of historical and current groundwater data using the Mann-Kendall non-parametric statistical test (Gilbert 1987) to investigate if COC concentrations in groundwater are increasing or decreasing. For monitoring wells where no trend could be statistically determined at the 95 percent confidence level, concentrations were deemed stable if the coefficient of variation (COV) was less than 1. Although approximate, the COV can indicate the relative variability of a dataset, especially with small sample sizes and in the absence of other formal tests (USEPA 2009b). Trend analyses were performed as follows:

- For each of the four key main chemical plant COC groups (CAHs, PHCs, carbon tetrachloride, and chloroform) plus a select group of "non-targeted" COCs (**Table 5**)
- For all of the WWTU COCs (select group of VOCs, SVOCs, and metals)

Several other main chemical plant COCs (e.g., 1,4-dioxane) are found in groundwater at the main chemical plant on a more isolated or irregular basis. These non-targeted main chemical plant COCs potentially pose risk above levels of concern for human and/or ecological receptors. Trend analysis was completed for a subset of main chemical plant monitoring wells for non-targeted COCs. The main chemical plant monitoring wells and non-targeted COCs that are evaluated are summarized in **Table 5**.

Five monitoring wells exhibited an increasing trend for one COC or COC group as summarized in **Table 6**. All other well results indicate decreasing trends using the Mann-Kendall test or stable concentrations as determined by the COV, or had insufficient data to generate trend using the Mann-Kendall test. The Mann-Kendall test requires at least six sample results for evaluation of a trend at the required confidence level; most WWTU wells had insufficient data to generate a trend using the Mann-Kendall test. By 2018, there will be a sufficient data set to evaluate all WWTU area wells and COCs.

The trend analysis results are provided in **Tables E-1** through **E-7** in **Appendix E**. Time series graphs of COCs with increasing or decreasing trends are provided in **Figures E-1** through **E-6**.

The groundwater performance metric for plume stability is considered achieved if more than 90 percent of the wells exhibit stable or decreasing concentrations of COCs and all sentinel wells exhibit stable or decreasing concentrations. Overall, 87 percent, or 33 of 38, of the main chemical plant monitoring wells exhibit stable or decreasing concentrations of COCs. The WWTU area wells were not included in this calculation due to insufficient data at most wells. Five monitoring wells exhibit increasing trends, three of which have relatively low COC concentrations close to the laboratory reporting limit, including sentinel wells TW-26 and TW-61, and Kanawha River boundary well TW-64 (**Table 6**). The concentrations at these wells have been steadily decreasing since 2012 in the case of TW-26 and TW-61, and nearly stable since 2010 in the case of TW-64. All other sentinel wells exhibit stable or decreasing concentrations. Two other monitoring wells (ENBN-I4 and TW-53) located near the center of the site and within or near an area of planned corrective action also exhibit an increasing trend (**Table 6**). The performance metric for plume stability has not been met.

3.3.3 Performance Standard 3: Reduction in Contaminant Mass

This performance standard is a measure of changes in water quality over time. The Thiessen polygon method (USEPA 1998) was used to assess total dissolved mass of constituents in the aquifer on a sitewide basis at the main chemical plant only in accordance with the PMP (CH2M 2011a). The distribution of the Thiessen polygons is shown on **Figure F-1** in **Appendix F**. The Mann-Kendall non-parametric statistical test was used to evaluate whether the calculated masses for the key COC groups are increasing or decreasing.

Mann-Kendall statistical results of key COC groups on a sitewide mass basis are provided in **Table F-1** in **Appendix F**. Graphs showing the change in mass over time are included on **Figure F-2**. All four main chemical plant COC groups (CAHs, PHCs, chloroform, and carbon tetrachloride) exhibit decreasing mass.

The groundwater performance standard for reduction in constituent mass is met if a reduction in groundwater COC mass is measured for each key COC grouping at the facility, or if the COC mass reaches asymptotic conditions after reducing over time. The performance standard for reduction of contaminant mass has been met because all four main COC groups exhibit decreasing trends.

SECTION 4

Summary and Conclusions

4.1 Summary

During the October 2015 groundwater performance monitoring sampling event, groundwater level measurements and samples were collected from monitoring wells in accordance with the PMP (CH2M 2014), including from both the main chemical plant and WWTU areas.

Similar to historical monitoring events, groundwater generally flows south toward the Kanawha River in the main chemical plant, with the groundwater gradient becoming steeper adjacent to the river. In the WWTU area, groundwater generally flows west-southwest.

Exceedances of the MCL/RSLs and/or site specific GWSLs were noted at 11 of 20 perimeter monitoring wells. The COC concentrations that exceed criteria are being addressed by focused corrective actions or selected remedies currently underway, or by planned offsite environmental covenants. Therefore, the groundwater performance standard for onsite containment was met.

Eighty-seven percent of the main chemical plant wells exhibited stable or decreasing concentrations of the CAH, PHC, carbon tetrachloride, chloroform, and non-targeted COC groups. The WWTU area wells were not included in this calculation due to an insufficient number of sampling events to establish trends. The performance metric of 90 percent was not met. Three monitoring wells, including sentinel wells TW-26 (PHCs) and TW-61 (CAHs) and perimeter well TW-64 (CAHs), have relatively low COC concentrations close to the laboratory reporting limit. Concentrations have been decreasing since 2012 in the case of TW-26 and TW-61, and nearly stable since 2010 in the case of TW-64. Two other interior wells, ENBN-I4 and TW-53, also exhibited increasing trends for PHCs and chloroform, respectively. Increasing COC concentrations at ENBN-I4 and TW-53 will be addressed through the remedial action planned at Area 3 in 2016.

The groundwater performance standard for reduction in constituent mass at main chemical plant wells was met for all key COC groups (CAHs, PHCs, carbon tetrachloride, and chloroform).

4.2 Conclusions

- Additional actions are not warranted at this time to address exceedances of site-specific GWSLs at Kanawha River perimeter monitoring wells MW-102, TW-63A, TW-63B, TW-66B, and TW-67B because they are being addressed as part of the HPH and Tank 1010 IRMs.
- Concentrations exceeding screening levels for 1,4-dioxane and 1,2-dichloroethane are present at perimeter monitoring wells TW-60A, TW-60B, or VW-15B along the western boundary of the site. Constituents of concern have migrated onto the AEP property based on investigation activities completed at the AEP property in 2010. There are no current potential exposures to relevant pathways. Future potential exposures will be addressed by a proposed environmental covenant on the AEP property. AEP and UCC are currently working to develop an appropriate covenant that would restrict groundwater use and eliminate potential exposure.
- Concentrations of 1,4-dioxane and 1,1-dichloroethane exceed screening levels in perimeter monitoring wells TW-65A and TW-65B along the eastern property boundary. Several phases of investigation were completed at the WVSU property from March 2013 through January 2016 as reported to the USEPA and WVDEP in the *Eastern Property Boundary RCRA Corrective Action Investigation – Phase II through V* technical memorandum (CH2M 2016). It is anticipated that future potential exposures will be addressed by a proposed environmental covenant on the property.

- WWTU area property boundary perimeter monitoring well W-10A exceeded the screening level for 1,4-dioxane. The Private Trucking Operations (PTO) site occupies the property downgradient/ adjacent to the WWTU area. PTO is owned by UCC. There are no current potential exposures to relevant pathways. Future potential exposures will be addressed by a proposed environmental covenant that will be developed and implemented on the property.
- No additional action is currently necessary to address monitoring wells that exhibit increasing COC trends within the facility due to the following and because potential human exposures are controlled by both current and planned institutional controls:
  - ENBN-I4 - The well is located within the Area 3 IRM area, where a corrective action is underway for groundwater impacts.
  - TW-26 (sentinel well) - The concentration of ethylbenzene (the main compound contributing to the increasing PHC trend) is low (1.93 µg/L). This concentration is below the GWSL of 7.3 µg/L and well below the MCL of 700 µg/L. In addition, concentrations at this well have been steadily decreasing since 2012.
  - TW-53 - This well is located downgradient of the Area 3 IRM area, where a corrective action is underway to address groundwater impacts.
  - TW-61 (sentinel well) - The concentration of 1,1-dichloroethane (the main compound contributing to the increasing CAH trend) is low (2.15 µg/L). This concentration is below the GWSL of 47 µg/L and below the RSL of 2.8 µg/L. In addition, concentrations at this well have been slightly decreasing since 2012.
  - TW-64 (Kanawha River perimeter well) - The concentration of vinyl chloride (the main compound contributing to the increasing CAH trend) is low (9.52 µg/L). This concentration is below the GWSL of 930 µg/L and slightly above the MCL of 2 µg/L. In addition, concentrations at this well have been stable since 2010.

These wells will be evaluated further after the next scheduled sampling event.

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Tables

Table 1. Groundwater Monitoring Well Network

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Well ID	Screened Lithology	Shallow or Deep Aquifer Zone[a]	Depth to Top of Screen (feet bgs)	Depth to Bottom of Screen (feet bgs)	Annual Monitoring Event Activity	Analytical Suites			Sentinel or Perimeter Monitoring Well	Part of Thiessen Network
						Site-Specific VOC List	Site-Specific SVOC List	Site-Specific Dissolved Metals List		
Main Chemical Plant Area Monitoring Wells										
ENBN-I4	Alluvial Aquifer	Deep	36	38	Sample+Water Level	X				X
MW-102	Alluvial Aquifer	Shallow	23	33	Sample+Water Level	X	X		Perimeter - River	X
MW-103	Alluvial Aquifer	Deep	41	51	Sample+Water Level	X	X		Perimeter - River	X
MW-104	Alluvial Aquifer	Shallow	NA	34*	Water Level					
TW-24	Alluvial Aquifer	Shallow	16	26	Water Level					
TW-26	Alluvial Aquifer	Shallow	16	26	Sample+Water Level	X			Sentinel	X
TW-29	Alluvial Aquifer	Shallow	19	29	Water Level					
TW-42	Alluvial Aquifer	Deep	43	53	Sample+Water Level	X				X
TW-45	Alluvial Aquifer	Shallow	20	30	Sample+Water Level	X				X
TW-46	Alluvial Aquifer	Deep	34	44	Sample+Water Level	X				X
TW-51	Alluvial Aquifer	Shallow	9	19	Water Level					
TW-52A	Alluvial Aquifer	Shallow	20	30	Sample+Water Level	X	X		Sentinel	X
TW-52B	Alluvial Aquifer	Deep	40	50	Sample+Water Level	X	X		Sentinel	X
TW-53	Alluvial Aquifer	Deep	36	46	Sample+Water Level	X			Sentinel	X
TW-54A	Alluvial Aquifer	Shallow	25	35	Sample+Water Level	X				X
TW-54B	Alluvial Aquifer	Deep	43	53	Sample+Water Level	X				X
TW-55	Alluvial Aquifer	Deep	30	40	Sample+Water Level	X				X
TW-56	Alluvial Aquifer	Deep	50	60	Sample+Water Level	X				X
TW-57	Alluvial Aquifer	Deep	35	45	Sample+Water Level	X				X
TW-58	Alluvial Aquifer	Shallow	15	25	Sample+Water Level	X			Sentinel	X
TW-59A	Alluvial Aquifer	Shallow	18	28	Sample+Water Level	X				X
TW-59B	Alluvial Aquifer	Deep	40	50	Sample+Water Level	X				X
TW-60A	Alluvial Aquifer	Shallow	16	26	Sample+Water Level	X	X		Perimeter - Property Boundary	X
TW-60B	Alluvial Aquifer	Deep	32	42	Sample+Water Level	X	X		Perimeter - Property Boundary	X
TW-61	Alluvial Aquifer	Deep	40	50	Sample+Water Level	X			Sentinel	X
TW-62A	Alluvial Aquifer	Shallow	17	27	Sample+Water Level	X			Sentinel	X
TW-62B	Alluvial Aquifer	Deep	40	50	Sample+Water Level	X			Sentinel	X
TW-63A	Silt/Clay Unit	NA	23	33	Sample+Water Level	X	X		Perimeter - River	X
TW-63B	Alluvial Aquifer	Deep	37	47	Sample+Water Level	X	X		Perimeter - River	X
TW-64	Alluvial Aquifer	Deep	41	51	Sample+Water Level	X			Perimeter - River	X
TW-65A	Alluvial Aquifer	Shallow	15	25	Sample+Water Level	X			Perimeter - Property Boundary	X
TW-65B	Alluvial Aquifer	Deep	45	55	Sample+Water Level	X	X		Perimeter - Property Boundary	X
TW-66B	Alluvial Aquifer	Deep	33	43	Sample+Water Level	X			Perimeter - River	X
TW-67B	Alluvial Aquifer	Deep	40.5	50.5	Sample+Water Level	X			Perimeter - River	X
TW-69A	Alluvial Aquifer	Shallow	20.3	30.3	Sample+Water Level	X				X
TW-70B	Alluvial Aquifer	Deep	34.2	44.2	Sample+Water Level	X				X
TW-71A	Alluvial Aquifer	Shallow	17	27	Sample+Water Level	X				X
TW-71B	Alluvial Aquifer	Deep	45	55	Sample+Water Level	X				X
VW-11A	Alluvial Aquifer	Shallow	16	26	Water Level					
VW-11B	Alluvial Aquifer	Deep	45	55	Water Level					
VW-12B	Alluvial Aquifer	Deep	43.5	53.5	Water Level					

Table 1. Groundwater Monitoring Well Network

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Well ID	Screened Lithology	Shallow or Deep Aquifer Zone[a]	Depth to Top of Screen (feet bgs)	Depth to Bottom of Screen (feet bgs)	Annual Monitoring Event Activity	Analytical Suites: Site-Specific VOC List	Site-Specific SVOC List	Site-Specific Dissolved Metals List	Sentinel or Perimeter Monitoring Well	Part of Thiessen Network
VW-15A	Alluvial Aquifer	Shallow	20	30	Sample+Water Level	X			Perimeter - River & Property Boundary	X
VW-15B	Alluvial Aquifer	Deep	39	49	Sample+Water Level	X			Perimeter - River & Property Boundary	X
VW-1A	Alluvial Aquifer	Shallow	20	30	Water Level					
VW-1B	Alluvial Aquifer	Deep	33	43	Water Level					
VW-2A	Alluvial Aquifer	Shallow	10	20	Water Level					
VW-2B	Alluvial Aquifer	Deep	40	50	Water Level					
VW-3A	Alluvial Aquifer	Shallow	21	31	Sample+Water Level	X			Perimeter - River & Property Boundary	X
VW-3B	Alluvial Aquifer	Deep	42	52	Sample+Water Level	X			Perimeter - River & Property Boundary	X
VW-4B	Alluvial Aquifer	Deep	40	50	Water Level					
VW-7AB	Alluvial Aquifer	Shallow	20	30	Water Level					
VW-9A	Alluvial Aquifer	Shallow	18	28	Water Level					
VW-9B	Alluvial Aquifer	Deep	48	58	Water Level					
WWTU Area Wells										
VW-16B	Alluvial Aquifer	Deep	46.33	56.33	Water Level					
VW-20A	Alluvial Aquifer	Shallow	22.09	32.09	Sample+Water Level	x	x	x		
VW-20B	Alluvial Aquifer	Deep	41.13	51.13	Water Level					
W-1B	Alluvial Aquifer	Deep	34.30	49.30	Water Level					
W-2A	Alluvial Aquifer	Deep	33.40	53.40	Sample+Water Level	x	x	x	Perimeter - River	
W-3	Silt/Clay Unit	NA	21.10	37.10	Sample+Water Level	x	x	x	Perimeter - River	
W-3A	Alluvial Aquifer	Deep	36.87	56.87	Water Level					
W-5	Silt/Clay Unit	NA	21.35	36.35	Sample+Water Level	x	x	x	Perimeter - River	
W-5A	Alluvial Aquifer	Deep	35.63	52.30	Sample+Water Level	x	x	x	Perimeter - River	
W-6B	Alluvial Aquifer	Deep	37.70	52.70	Water Level					
W-7A	Alluvial Aquifer	Deep	36.40	50.40	Water Level					
W-8	Alluvial Aquifer	Deep	10.00	30.00	Water Level					
W-10A	Alluvial Aquifer	Deep	33.38	50.80	Sample+Water Level	x	x	x	Perimeter - Property Boundary	
W-11A	Alluvial Aquifer	Deep	33.00	53.00	Water Level					
W-13A	Alluvial Aquifer	Deep	29.85	49.85	Water Level					
W-14	Silt/Clay Unit	NA	13.60	33.60	Sample+Water Level	x	x	x	Perimeter - River	

Notes:

bgs = below ground surface

NA = not applicable

WWTU = Wastewater Treatment Unit

[a] Screened zones: Shallow = <30 ft-bgs; Deep = >30 ft-bgs

* Based on measured total depth.

Table 2. Groundwater Elevation Data

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Monitoring Well	Date	Total Depth at Installation (ft btoc)	Measured Total Depth (ft btoc)	Depth to GW (ft btoc)	TOC Elevation (ft amsl)	GW Elevation (ft amsl)
Main Chemical Plant Area Monitoring Wells						
ENBN-I4	10/13/2015	37	37.67	19.05	601.02	581.97
MW-102	10/13/2015	33	32.97	16.80	595.18	578.38
MW-103	10/13/2015	51	51.20	27.32	594.50	567.18
MW-104	10/14/2015	34	34.10	15.82	596.40	580.58
TW-24	10/14/2015	26	26.00	13.91	595.08	581.17
TW-26	10/13/2015	26	25.50	15.70	595.10	579.40
TW-29	10/14/2015	29	28.46	17.62	599.44	581.82
TW-42	10/13/2015	53	53.35	15.10	597.10	582.00
TW-45	10/14/2015	30	27.40	15.07	596.78	581.71
TW-46	10/14/2015	44	43.60	16.40	598.18	581.78
TW-51	10/14/2015	29	29.21	16.93	598.79	581.86
TW-52A	10/13/2015	30	30.20	12.75	594.51	581.76
TW-52B	10/13/2015	50	50.00	12.70	594.40	581.70
TW-53	10/13/2015	46	46.10	13.40	595.70	582.30
TW-54A	10/13/2015	35	35.00	16.40	598.41	582.01
TW-54B	10/13/2015	53	53.56	16.55	598.54	581.99
TW-55	10/13/2015	40	40.20	16.20	598.21	582.01
TW-56	10/14/2015	60	59.20	18.11	599.79	581.68
TW-57	10/13/2015	45	45.27	14.31	595.44	581.13
TW-58	10/13/2015	25	25.00	12.71	594.10	581.39
TW-59A	10/13/2015	28	29.20	13.24	595.20	581.96
TW-59B	10/13/2015	50	50.81	13.33	595.29	581.96
TW-60A	10/13/2015	26	23.91	9.75	591.46	581.71
TW-60B	10/13/2015	42	44.90	9.94	591.52	581.58
TW-61	10/13/2015	50	49.80	15.65	594.93	579.28
TW-62A	10/13/2015	27	26.60	12.69	592.03	579.34
TW-62B	10/13/2015	50	49.50	11.83	592.13	580.30
TW-63A	10/14/2015	33	33.30	17.75	592.89	575.14
TW-63B	10/14/2015	47	47.20	23.36	592.89	569.53
TW-64	10/13/2015	51	NM	NM	592.82	NM
TW-65A	10/13/2015	25	25.35	16.59	595.32	578.73
TW-65B	10/13/2015	55	55.07	17.30	595.30	578.00
TW-66B	10/14/2015	43	43.63	18.52	593.83	575.31
TW-67B	10/13/2015	50.5	50.83	20.09	592.29	572.20
TW-69A	10/14/2015	30.3	29.61	17.86	599.32	581.46
TW-70B	10/14/2015	44.2	43.96	17.40	599.72	582.32
TW-71A	10/14/2015	27	26.68	16.71	596.96	580.25
TW-71B	10/14/2015	55	54.90	16.50	597.14	580.64
VW-1A	10/14/2015	30	34.30	22.75	604.61	581.86
VW-1B	10/14/2015	43	44.90	21.87	603.70	581.83
VW-2A	10/13/2015	20	21.70	13.90	594.87	580.97
VW-2B	10/13/2015	50	51.20	13.42	595.16	581.74
VW-3A	10/13/2015	31	32.90	20.14	595.38	575.24
VW-3B	10/13/2015	52	53.20	21.38	595.59	574.21
VW-4B	10/14/2015	50	46.61	16.21	596.61	580.40
VW-7AB	10/14/2015	30	31.72	4.85	611.26	606.41
VW-9A	10/14/2015	28	29.21	19.68	601.20	581.52
VW-9B	10/14/2015	58	59.30	19.86	600.96	581.10
VW-11A	10/14/2015	26	27.50	27.50	600.16	DRY

Table 2. Groundwater Elevation Data

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Monitoring Well	Date	Total Depth at Installation (ft btoc)	Measured Total Depth (ft btoc)	Depth to GW (ft btoc)	TOC Elevation (ft amsl)	GW Elevation (ft amsl)
VW-11B	10/14/2015	55	56.43	18.74	600.12	581.38
VW-12B	10/14/2015	53.5	56.11	22.11	595.71	573.60
VW-15A	10/13/2015	30	31.90	16.75	594.15	577.40
VW-15B	10/13/2015	49	51.60	21.60	593.72	572.12
Wastewater Treatment Unit						
W-1A**	10/16/2015	34.1	34.65	9.96	591.21	581.25
W-1B	10/16/2015	49.3	NM	NM	591.01	NM
W-2A	10/15/2015	53.4	NM*	NM*	597.03	NM*
W-3	10/15/2015	35.8	37.00	14.46	596.15	581.69
W-3A	10/15/2015	54.6	NM*	NM*	597.49	NM*
W-5	10/15/2015	35.5	36.45	11.90	595.83	583.93
W-5A	10/15/2015	52.3	54.90	20.62	596.16	575.54
W-6B	10/15/2015	52.7	54.42	17.35	595.89	578.54
W-7A	10/16/2015	50.4	53.02	11.58	592.54	580.96
W-8	10/16/2015	30.0	32.25	9.00	591.73	582.73
W-10A	10/16/2015	50.8	53.27	17.10	593.09	575.99
W-11A	10/16/2015	53.0	55.40	17.07	596.35	579.28
W-13A	10/16/2015	48.2	49.68	10.00	590.31	580.31
W-14	10/16/2015	33.6	NM	NM	594.64	NM
W-14A**	10/15/2015	53.7	56.12	22.45	595.52	573.07
VW-16B	10/16/2015	56.0	56.00	18.85	596.95	578.10
VW-20A	10/15/2015	30.0	32.13	14.60	590.97	576.37
VW-20B	10/15/2015	52.0	51.20	14.90	591.33	576.43

Notes:

ft btoc = feet below top of casing

ft amsl = feet above mean sea level

GW = groundwater

NM = not measured

NA = not available

TOC = top of casing

*Pump stuck near bottom of well.

**Well inadvertently measured.

Table 3. Summary of Applicable Screening Criteria Perimeter Monitoring Wells

2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia

Well ID	Apply USEPA MCLs/Tap Water RSLs to Groundwater Data (Wells Adjacent to Property Boundary)?	Apply Site-Specific GWSLs/BTAG ESLs to Groundwater Data (Wells Adjacent to Kanawha River)?
MW-102		X
MW-103		X
TW-60A	X	
TW-60B	X	
TW-63A		X
TW-63B		X
TW-64		X
TW-65A	X	
TW-65B	X	
TW-66B		X
TW-67B		X
VW-15A	X	X
VW-15B	X	X
VW-3A	X	X
VW-3B	X	X
W-2A		X
W-3		X
W-5		X
W-5A		X
W-10A	X	
W-14		X

Notes:

BTAG ESL = USEPA Biological Technical Assistance Group Region 3 ecological screening level (USEPA 2006)
GWSL = groundwater screening level
MCL = Maximum Contaminant Level (USEPA 2009a)
RSL = Regional Screening Level (USEPA 2015)
USEPA = United States Environmental Protection Agency

Table 4. Performance Monitoring Standard #1, Onsite Containment - Summary of Exceedances

2015 Groundwater Performance Monitoring Repc

Union Carbide Corporation Institute Facility, Institute, West Virginia

Well ID	Offsite Pathway	One or More MCL/RSLs Exceeded (WVDA/AEP Pathway)	One or More Site-Specific GWSLs or BTAG ESL Exceeded (River Pathway)	Corrective Action Or Selected Remedy Underway	Offsite Environmental Covenant Planned
MW-102	River	N/A	X	X	
TW-63A	River	N/A	X	X	
TW-63B	River	N/A	X	X	
TW-66B	River	N/A	X	X	
TW-67B	River	N/A	X	X	
VW-15B	River/AEP	X			X
TW-60A	AEP	X	N/A		X
TW-60B	AEP	X	N/A		X
TW-65A	WVSU	X	N/A		X
TW-65B	WVSU	X	N/A		X
W-10A	PTO	X	N/A		X

Notes:

BTAG ESL = USEPA Biological Technical Assistance Group Region 3 ecological screening level (USEPA 2006)
GWSL = groundwater screening level
MCL = Maximum Contaminant Level (USEPA 2009a)
N/A = not applicable
RSL = Regional Screening Level (USEPA 2015)
AEP = Appalachian Electric Power (located west of the main chemical plant)
PTO = Private Trucking Operations (located west of WWTU)
WVSU = West Virginia State University (located east of the main chemical plant)

Table 5. Other Targeted COCs and Applicable Wells

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Well ID	Dichlorodifluoro-methane	Trichlorofluoro-methane	1,4-Dioxane	Bis(2-chloroethyl) ether	Bis(2-chloroiso-propyl) ether	Phenol
ENBN-I4		X				
MW-102						X
TW-45	X					
TW-52A				X	X	
TW-52B				X	X	
TW-54B		X				
TW-56	X	X				
TW-57	X	X				
TW-60A			X			
TW-60B			X			
TW-63A						X
TW-63B						X
TW-65B			X			

Notes:

COC = constituent of concern

Table 6. Performance Monitoring Standard #2, Plume Stability - Summary of Increasing Trends

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Monitoring Well	COC Group	Range of Data (µg/L)	2015 Concentration (µg/L)	Main Compound Contributing to Trend	Trend
ENBN-I4	PHCs	305 to 684	514	Benzene	Strong Increasing
TW-26 (sentinel well)	PHCs	0.5 U[a] to 7.75	4.58	Ethylbenzene	Strong Increasing
TW-61 (sentinel well)	CAHs	1 U[a] to 8.9	3.15	1,1-Dichloroethane	Strong Increasing
TW-64 (perimeter well - river)	CAHs	1 U[a] to 15.1	12	Vinyl Chloride	Strong Increasing
TW-53	Chloroform	0.5 U[a] to 33.3	25.4	Chloroform	Strong Increasing

Notes:

[a] U = not detected

COC = constituent of concern

CAH = chlorinated aliphatic hydrocarbon

PHC = petroleum hydrocarbon

µg/L = micrograms per liter

Figures

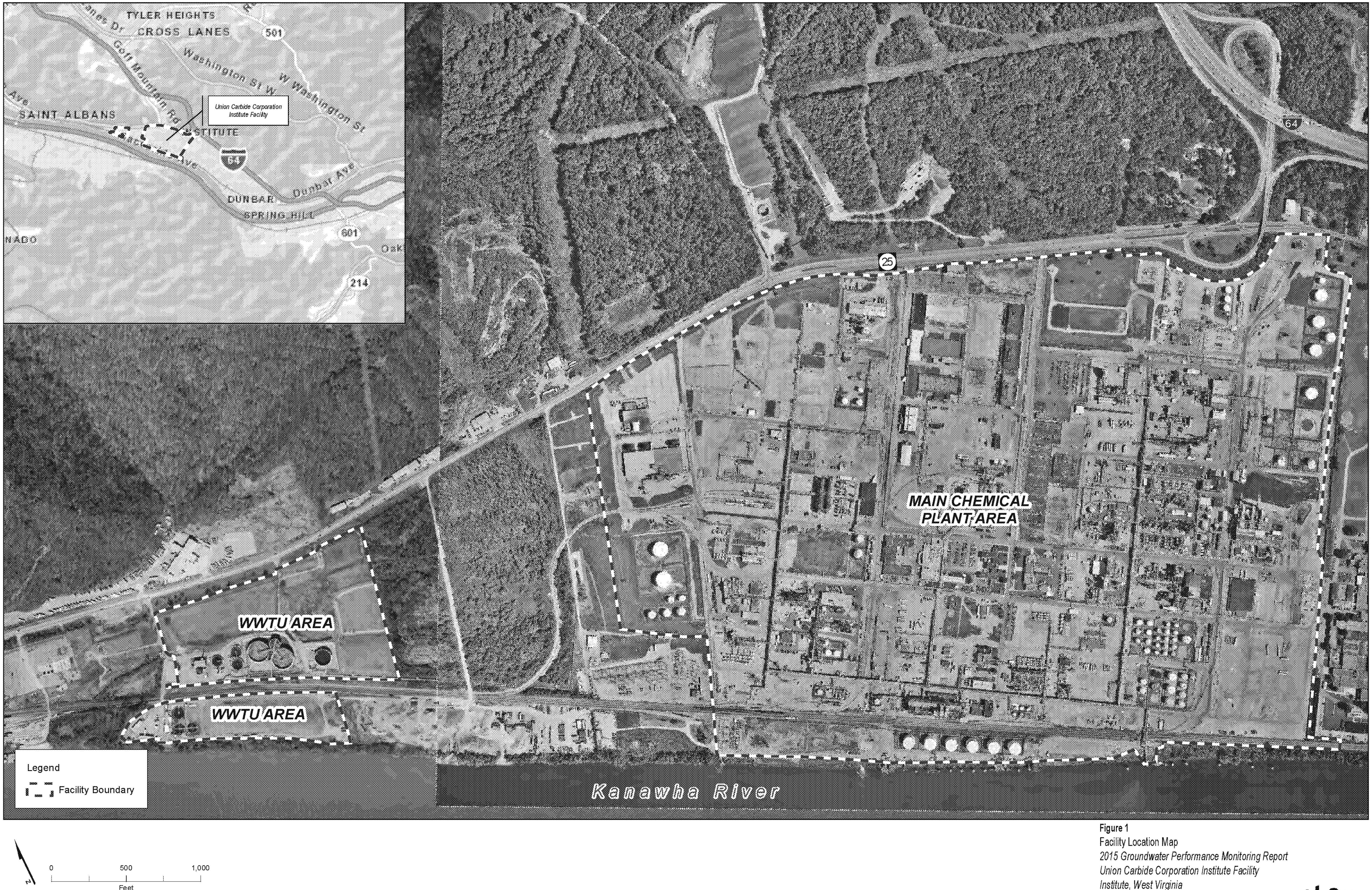

Figure 1
Facility Location Map
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility
Institute, West Virginia

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Figure 2
Interim Remedial Measure Areas
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility
Institute, West Virginia

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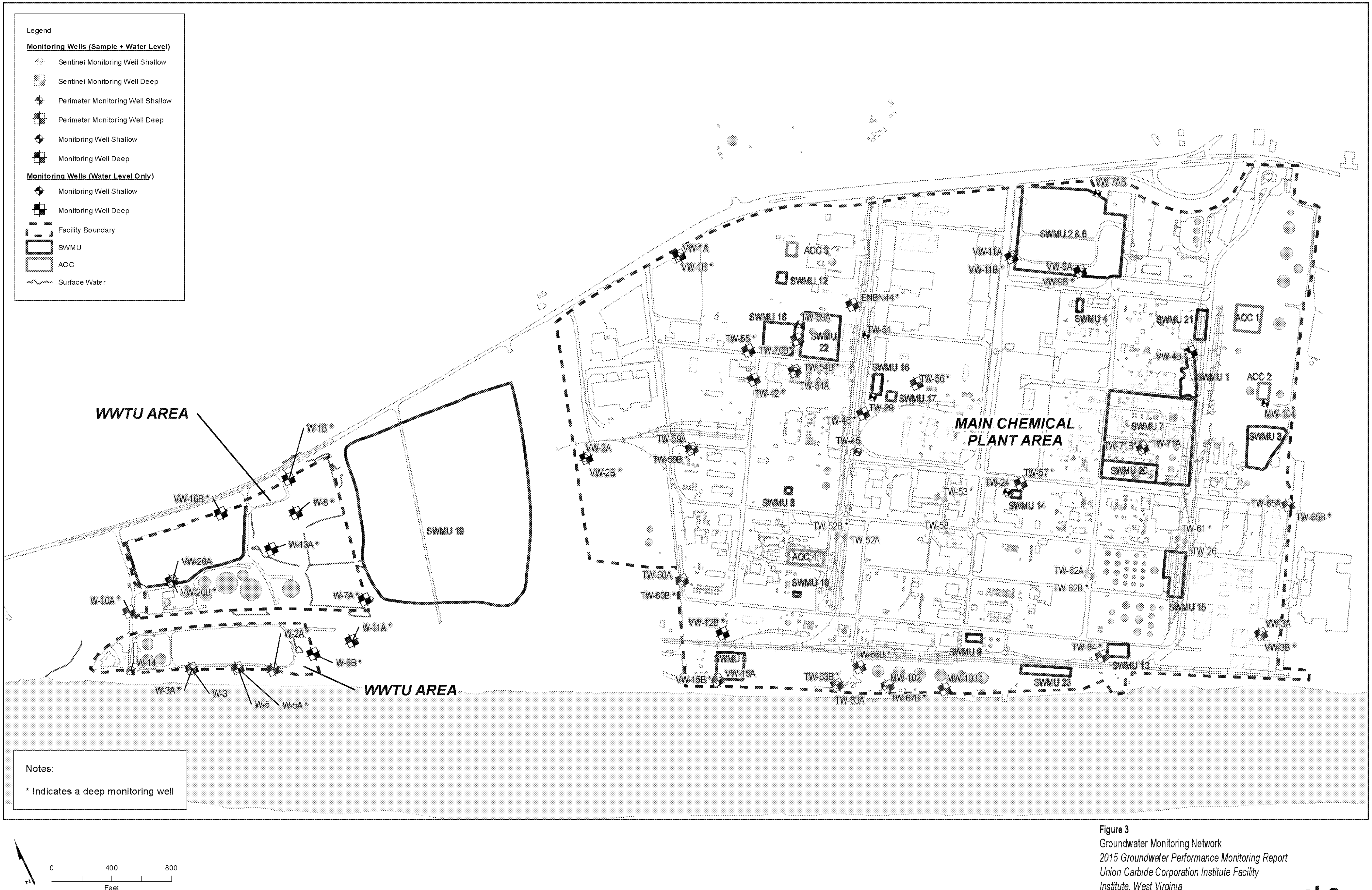

Figure 3
Groundwater Monitoring Network
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility
Institute, West Virginia

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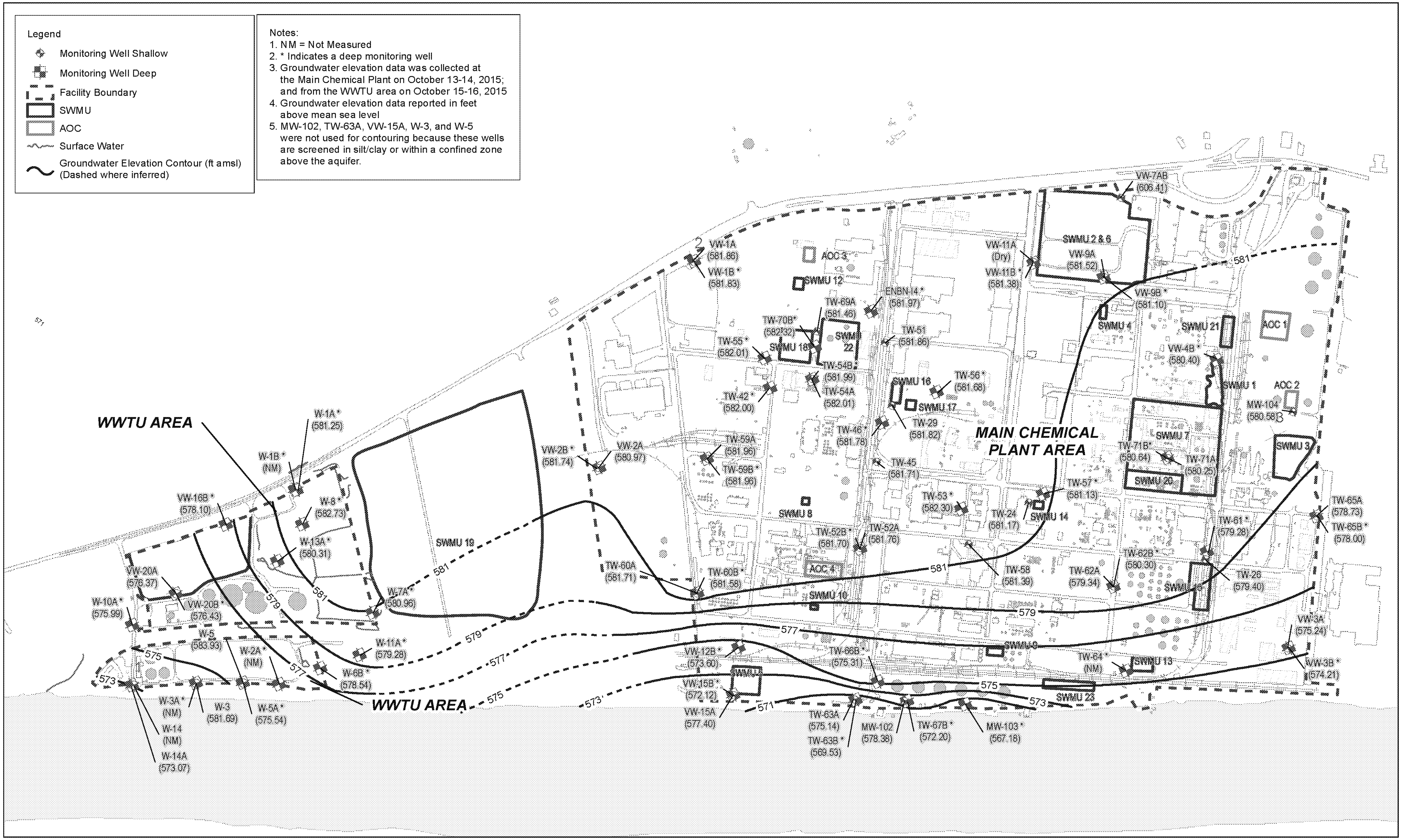

Legend
- Monitoring Well Shallow
- Monitoring Well Deep
- Facility Boundary
- SWMU
- AOC
- Surface Water
- Groundwater Elevation Contour (ft amsl) (Dashed where inferred)

Notes:
1. NM = Not Measured
2. * Indicates a deep monitoring well
3. Groundwater elevation data was collected at the Main Chemical Plant on October 13-14, 2015; and from the WWTU area on October 15-16, 2015
4. Groundwater elevation data reported in feet above mean sea level
5. MW-102, TW-63A, VW-15A, W-3, and W-5 were not used for contouring because these wells are screened in silt/clay or within a confined zone above the aquifer.

N

0 400 800
Feet

Figure 4
Potentiometric Surface Map
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility
Institute, West Virginia

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Appendix A
Analytical Data Summary Table

Table A-1. Analytical Data Summary Table
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia

Location	ENBN-I4	MW-102	MW-103	TW-26	TW-42	TW-45	TW-46	TW-52A	TW-52B	TW-53	TW-54A	TW-54B	TW-55
Sample ID	ENBNI4-GW-102215	MW102-GW-102015	MW103-GW-102015	TW26-GW-101915	TW42-GW-102215	TW45-GW-102215	TW46-GW-102315	TW52A-GW-102015	TW52B-GW-102115	TW53-GW-102215	TW54A-GW-102215	TW54B-GW-102315	TW55-GW-102115
Sample Depth (ft)	35 - 37	23 - 33	41 - 51	16 - 26	43 - 53	20 - 30	34 - 44	20 - 30	40 - 50	36 - 46	25 - 35	43 - 53	30 - 40
Sample Date	10/22/2015	10/20/2015	10/20/2015	10/19/2015	10/22/2015	10/22/2015	10/23/2015	10/20/2015	10/21/2015	10/22/2015	10/22/2015	10/23/2015	10/21/2015
Metals (MG/L)													
Beryllium, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Cadmium, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Cobalt, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Lead, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Manganese, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SVOCs (µg/L)													
2-Methylnaphthalene	- -	0.556 U	0.51 U	- -	- -	- -	- -	0.61 U	0.5 U	- -	- -	- -	- -
Benzo (b) fluoranthene	- -	0.556 U	0.51 U	- -	- -	- -	- -	0.61 U	0.5 U	- -	- -	- -	- -
Bis (2-chloroethyl) ether	- -	0.556 U	**2.28**	- -	- -	- -	- -	**26.5**	**15.5**	- -	- -	- -	- -
Bis (2-chloroisopropyl) ether	- -	0.556 U	**1.7**	- -	- -	- -	- -	**18.6**	**69.3**	- -	- -	- -	- -
Bis (2-ethylhexyl) phthalate	- -	5.56 U	5.1 U	- -	- -	- -	- -	6.1 U	5 U	- -	- -	- -	- -
Ethyl ether	**74.3**	10 U	**418**	10 U	500 U	50 U	200 U	10 U	**21.4**	**541**	200 U	50 U	50 U
Hexachloroethane	- -	0.556 U	0.51 U	- -	- -	- -	- -	0.61 U	0.5 U	- -	- -	- -	- -
Isophorone	- -	0.556 U	0.51 U	- -	- -	- -	- -	0.61 U	0.5 U	- -	- -	- -	- -
Naphthalene	2.5 U	**1.46**	**4.92**	**2.21**	50 U	5 U	20 U	0.61 U	0.5 U	5 U	20 U	5 U	5 U
Phenol	- -	**6.83**	0.51 U	- -	- -	- -	- -	0.61 U	0.5 U	- -	- -	- -	- -
VOCs (µg/L)													
1,1,2,2-Tetrachloroethane	2.5 U	1 U	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	**5.79**	5 U
1,1,2-Trichloroethane	2.5 U	1 U	1 U	1 U	50 U	**21.3**	20 U	1 U	1 U	**58.9**	20 U	5 U	5 U
1,1-Dichloroethane	2.5 U	1 U	1 U	1 U	50 U	5 U	20 U	**4.06**	**3.33**	5 U	20 U	5 U	5 U
1,1-Dichloroethene	2.5 U	1 U	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	**5.12**
1,2,4-Trimethylbenzene	2.5 U	**1.84**	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
1,2-Dichloroethane	2.5 U	1 U	1 U	1 U	50 U	**7.65**	**75.4**	1 U	1 U	**12.2**	20 U	5 U	5 U
1,2-Dichloropropane	2.5 U	1 U	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
1,3,5-Trimethylbenzene	2.5 U	1 U	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
1,3-Dichlorobenzene	2.5 U	1 U	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
1,4-Dichlorobenzene	2.5 U	1 U	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
1,4-Dioxane (p-Dioxane)	- -	1.11 U	**14.4 L**	- -	- -	- -	- -	1.22 U	**42.2**	- -	- -	- -	- -
2-Butanone	**184**	5 U	5 U	5 U	250 U	25 U	100 U	5 U	5 U	25 U	100 U	25 U	25 U
2-Hexanone	12.5 U	5 U	5 U	5 U	250 U	25 U	100 U	5 U	5 U	25 U	100 U	25 U	25 U
4-Methyl-2-pentanone	12.5 U	5 U	5 U	5 U	250 U	25 U	100 U	5 U	5 U	25 U	100 U	25 U	25 U
Acetone	**350 L**	5 UL	5 UL	5 UL	250 UL	**28.9 L**	100 UL	5 UL	5 UL	25 UL	100 UL	25 UL	25 UL
Benzene	**512**	**142**	1 U	1 U	50 U	**12.2**	20 U	1 U	**1.67**	**29.6**	20 U	5 U	**82.9**
Bromodichloromethane	2.5 U	1 U	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
Bromomethane	2.5 U	1 U	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
Carbon disulfide	2.5 U	1 UJ	1 UL	1 U	50 U	5 UL	20 UL	1 UJ	1 UJ	5 UL	20 U	5 U	5 UJ
Carbon tetrachloride	2.5 U	1 U	1 U	1 U	**1230**	5 U	20 U	1 U	1 U	5 U	**188**	5 U	**41.5**
Chlorobenzene	2.5 U	1 U	1 U	**1.45**	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
Chloroform	**18.6**	1 U	1 U	1 U	**6130**	**38.5**	**1730**	1 U	1 U	**25.4**	**196**	**409**	**23**
Chloromethane	2.5 U	1 U	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
cis-1,2-Dichloroethylene	2.5 U	1 U	1 U	1 U	50 U	5 U	**46.1**	1 U	**2.38**	5 U	**50.3**	**109**	5 U
Dibromochloromethane	2.5 U	1 U	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
Dichlorodifluoromethane	**34.6 J**	1 U	1 U	1 U	50 UJ	**813**	**658**	1 U	1 U	**809**	20 UJ	**42.9 J**	**42.4**
Ethylbenzene	2.5 U	1 U	1 U	**1.93**	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
Methylene chloride	**43**	1 U	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
Styrene	2.5 U	1 U	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
Tetrachloroethene	**7.87**	1 U	1 U	1 U	50 U	5 U	**551**	1 U	1 U	5 U	**3260**	**4190**	5 U
Toluene	2.5 U	**1.11**	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U
Trans-1,2-Dichloroethylene	2.5 U	1 U	1 U	1 U	50 U	5 U	20 U	1 U	**1**	5 U	20 U	5 U	5 U
Trichloroethylene	2.5 U	1 U	1 U	1 U	50 U	**8.46**	20 U	1 U	**3.63**	5 U	20 U	**24.2**	5 U
Trichlorofluoromethane	**4950 J**	1 UJ	1 UJ	1 U	**566**	**10.9 J**	**3460 J**	1 UJ	1 UJ	**9.44 J**	**405**	**2140 J**	**456 J**
Vinyl chloride	2.5 U	1 U	1 U	1 U	50 U	**38.2**	20 U	1 U	1 U	**238**	20 U	5 U	5 U
Xylenes, Total	2.5 U	**27.5**	1 U	1 U	50 U	5 U	20 U	1 U	1 U	5 U	20 U	5 U	5 U

Notes are located on page 5 of 5

Table A-1. Analytical Data Summary Table
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia

Location	TW-56		TW-57	TW-58	TW-59A	TW-59B	TW-60A	TW-60B	TW-61	TW-62A	TW-62B	TW-63A	TW-63B
Sample ID	TW56-GW-102315	TW56-GW-102315D	TW57-GW-102315	TW58-GW-101915	TW59A-GW-102115	TW59B-GW-102215	TW60A-GW-102115	TW60B-GW-101915	TW61-GW-102115	TW62A-GW-102115	TW62B-GW-102115	TW63A-GW-101915	TW63B-GW-101915
Sample Depth (ft)	50 - 60	50 - 60	35 - 45	15 - 25	18 - 28	40 - 50	16 - 26	32 - 42	40 - 50	17 - 27	40 - 50	23 - 33	37 - 47
Sample Date	10/23/2015	10/23/2015	10/23/2015	10/19/2015	10/21/2015	10/22/2015	10/21/2015	10/19/2015	10/21/2015	10/21/2015	10/21/2015	10/19/2015	10/19/2015
Metals (MG/L)													
Beryllium, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Cadmium, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Cobalt, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Lead, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Manganese, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SVOCs (µg/L)													
2-Methylnaphthalene	- -	- -	- -	- -	- -	- -	0.526 U	0.595 U	- -	- -	- -	0.575 UL	0.562 UL
Benzo (b) fluoranthene	- -	- -	- -	- -	- -	- -	0.526 U	0.595 U	- -	- -	- -	0.575 UL	0.562 UL
Bis (2-chloroethyl) ether	- -	- -	- -	- -	- -	- -	0.526 U	0.595 U	- -	- -	- -	0.575 UL	0.562 UL
Bis (2-chloroisopropyl) ether	- -	- -	- -	- -	- -	- -	0.526 U	0.595 U	- -	- -	- -	0.575 UL	0.562 UL
Bis (2-ethylhexyl) phthalate	- -	- -	- -	- -	- -	- -	5.26 U	5.95 U	- -	- -	- -	5.75 UL	5.62 UL
Ethyl ether	2500 U	2500 U	1000 U	10 U	10 U	25 U	10 U	10 U	10 U	**32**	**5810**	500 U	**75.4**
Hexachloroethane	- -	- -	- -	- -	- -	- -	0.526 U	0.595 U	- -	- -	- -	0.575 UL	0.562 UL
Isophorone	- -	- -	- -	- -	- -	- -	0.526 U	0.595 UL	- -	- -	- -	**0.596 L**	0.562 UL
Naphthalene	250 U	250 U	100 U	1 U	1 U	2.5 U	0.526 U	0.595 U	1 U	1 U	10 U	**134**	**4.32**
Phenol	- -	- -	- -	- -	- -	- -	0.526 U	0.595 U	- -	- -	- -	**200**	**3.4**
VOCs (µg/L)													
1,1,2,2-Tetrachloroethane	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
1,1,2-Trichloroethane	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
1,1-Dichloroethane	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	**2.15**	1 U	10 U	50 U	1 U
1,1-Dichloroethene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
1,2,4-Trimethylbenzene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
1,2-Dichloroethane	250 U	250 U	**2220**	1 U	1 U	**3.45**	1 U	1 U	1 U	1 U	10 U	50 U	1 U
1,2-Dichloropropane	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
1,3,5-Trimethylbenzene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
1,3-Dichlorobenzene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	**2.48**	10 U	50 U	1 U
1,4-Dichlorobenzene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	**9.75**	10 U	50 U	1 U
1,4-Dioxane (p-Dioxane)	- -	- -	- -	- -	- -	- -	**15.8**	**3.87 L**	- -	- -	- -	1.15 U	**5.77**
2-Butanone	1250 U	1250 U	500 U	5 U	5 U	12.5 U	5 U	5 U	5 U	5 U	50 U	250 U	5 U
2-Hexanone	1250 U	1250 U	500 U	5 U	5 U	12.5 U	5 U	5 U	5 U	5 U	50 U	250 U	5 U
4-Methyl-2-pentanone	1250 U	1250 U	500 U	5 U	5 U	12.5 U	5 U	5 U	5 U	5 U	50 U	250 U	5 U
Acetone	1250 UL	1250 UL	500 UL	5 UL	5 UL	12.5 UL	5 UL	5 UL	5 UL	**12.2 L**	50 UL	250 UL	5 UL
Benzene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	**1.02**	**12.5**	**23000**	**37.6**
Bromodichloromethane	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
Bromomethane	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
Carbon disulfide	**920 L**	**381 L**	100 UL	1 U	1 UJ	2.5 U	1 UJ	1 U	1 UJ	1 UJ	**44 J**	50 U	1 U
Carbon tetrachloride	**371**	**370**	**262**	1 U	**53.4**	**1400**	1 U	1 U	**1.16**	1 U	10 U	50 U	1 U
Chlorobenzene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	**185**	10 U	50 U	1 U
Chloroform	**9250**	**9060**	**21300**	1 U	**16.6**	**114**	1 U	1 U	**14.6**	1 U	10 U	50 U	1 U
Chloromethane	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
cis-1,2-Dichloroethylene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
Dibromochloromethane	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
Dichlorodifluoromethane	**913**	**909**	**2580**	1 U	1 U	**7.01 J**	1 U	1 U	**85.2**	1 U	10 U	50 U	1 U
Ethylbenzene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	**1610**	**24.9**
Methylene chloride	**279**	**285**	**171**	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
Styrene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
Tetrachloroethene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
Toluene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	**190**	**1.26**
Trans-1,2-Dichloroethylene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
Trichloroethylene	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	50 U	1 U
Trichlorofluoromethane	**25700 J**	**25600 J**	**7720 J**	1 U	1 UJ	**27.1**	1 UJ	1 U	**83.4 J**	1 UJ	10 UJ	50 U	1 U
Vinyl chloride	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	**90.9**	50 U	1 U
Xylenes, Total	250 U	250 U	100 U	1 U	1 U	2.5 U	1 U	1 U	1 U	1 U	10 U	**327**	**9.63**

Notes are located on page 5 of 5

Table A-1. Analytical Data Summary Table
2015 Groundwater Performance
Monitoring Report
Union Carbide Corporation Institute
Facility, Institute, West Virginia

Location	TW-64	TW-65A	TW-65B	TW-66B	TW-67B	TW-69A	TW-70B	TW-71A	TW-71B	VW-03A	VW-03B	VW-15A
Sample ID	TW64-GW-021616	TW65A-GW-102015	TW65B-GW-102015	TW66B-GW-102015	TW67B-GW-101915	TW69A-GW-102315	TW70B-GW-102315	TW71A-GW-102615	TW71B-GW-102615	VW3A-GW-101915	VW3B-GW-102115	VW15A-GW-102115
Sample Depth (ft)	41 - 51	15 - 25	45 - 55	33 - 43	40.5 - 50.5	20 - 30	34 - 44	17 - 27	45 - 55	21 - 31	42 - 52	20 - 30
Sample Date	2/16/2016	10/20/2015	10/20/2015	10/20/2015	10/19/2015	10/23/2015	10/23/2015	10/26/2015	10/26/2015	10/19/2015	10/21/2015	10/21/2015
Metals (MG/L)												
Beryllium, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Cadmium, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Cobalt, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Lead, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Manganese, dissolved	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SVOCs (µg/L)												
2-Methylnaphthalene	- -	- -	0.532 U	- -	- -	- -	- -	- -	- -	- -	- -	- -
Benzo (b) fluoranthene	- -	- -	0.532 U	- -	- -	- -	- -	- -	- -	- -	- -	- -
Bis (2-chloroethyl) ether	- -	- -	0.532 U	- -	- -	- -	- -	- -	- -	- -	- -	- -
Bis (2-chloroisopropyl) ether	- -	- -	0.532 U	- -	- -	- -	- -	- -	- -	- -	- -	- -
Bis (2-ethylhexyl) phthalate	- -	- -	5.32 U	- -	- -	- -	- -	- -	- -	- -	- -	- -
Ethyl ether	**1200**	10 U	10 U	2500 U	1000 U	500 U	500 U	25 U	10 U	10 U	10 U	10 U
Hexachloroethane	- -	- -	0.532 U	- -	- -	- -	- -	- -	- -	- -	- -	- -
Isophorone	- -	- -	0.532 U	- -	- -	- -	- -	- -	- -	- -	- -	- -
Naphthalene	5 U	1 U	0.532 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
Phenol	- -	- -	0.532 U	- -	- -	- -	- -	- -	- -	- -	- -	- -
VOCs (µg/L)												
1,1,2,2-Tetrachloroethane	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	5 U	**6.23**	**1.85**	250 U	100 U	50 U	50 U	2.5 U	**1.83**	1 U	1 U	1 U
1,1-Dichloroethene	5 U	**1.82**	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
1,2,4-Trimethylbenzene	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
1,2-Dichloropropane	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
1,3,5-Trimethylbenzene	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	5 U	1 U	1 U	250 U	100 U	50 U	50 U	**26.8**	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	5 U	1 U	1 U	250 U	100 U	50 U	50 U	**98.7**	1 U	1 U	1 U	1 U
1,4-Dioxane (p-Dioxane)	- -	- -	**19.5**	- -	- -	- -	- -	- -	- -	- -	- -	- -
2-Butanone	25 U	5 U	5 U	1250 U	500 U	250 U	250 U	12.5 U	5 U	5 U	5 U	5 U
2-Hexanone	25 U	5 U	5 U	1250 U	500 U	250 U	250 U	12.5 U	5 U	5 U	5 U	5 U
4-Methyl-2-pentanone	25 U	5 U	5 U	1250 U	500 U	250 U	250 U	12.5 U	5 U	5 U	5 U	5 U
Acetone	25 UL	5 UL	**36 L**	1250 UL	500 UL	250 UL	250 UL	12.5 UL	5 UL	5 UL	**14.4 L**	5 UL
Benzene	5 U	1 U	1 U	**104000**	**44300**	**7360**	**1680**	2.5 U	**30.2**	1 U	1 U	1 U
Bromodichloromethane	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
Bromomethane	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
Carbon disulfide	5 U	1 UJ	1 UJ	**733 J**	100 U	50 UL	**156 L**	2.5 UL	1 UL	1 U	1 UJ	1 UJ
Carbon tetrachloride	5 U	1 U	1 U	250 U	100 U	50 U	**228**	2.5 U	1 U	1 U	1 U	1 U
Chlorobenzene	5 U	1 U	1 U	250 U	100 U	50 U	50 U	**223**	**75.6**	1 U	**1.84**	1 U
Chloroform	5 U	1 U	1 U	250 U	100 U	**476**	**3830**	2.5 U	2.44 B	1 U	**3.67**	1 U
Chloromethane	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethylene	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
Dibromochloromethane	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
Dichlorodifluoromethane	5 U	1 U	1 U	250 U	100 U	**284**	**850**	2.5 U	1 U	1 U	**12.8**	1 U
Ethylbenzene	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
Methylene chloride	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
Styrene	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
Toluene	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
Trans-1,2-Dichloroethylene	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
Trichloroethylene	5 U	1 U	1 U	250 U	500 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	5 U	1 UJ	1 UJ	250 UJ	100 U	**3200 J**	**6120 J**	2.5 UJ	1 UJ	1 U	**41.9 J**	1 UJ
Vinyl chloride	**9.52**	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U
Xylenes, Total	5 U	1 U	1 U	250 U	100 U	50 U	50 U	2.5 U	1 U	1 U	1 U	1 U

Notes are located on page 5 of 5

Table A-1. Analytical Data Summary Table
2015 Groundwater Performance
Monitoring Report
Union Carbide Corporation Institute
Facility, Institute, West Virginia

Location	VW-15B		VW-20A	W-10A	W-14		W-3	W-5	W-5A
Sample ID	VW15B-GW-102215	VW15B-GW-102215D	WV20A-GW-102815	W10A-GW-102915	W14-GW-102815	W14-GW-102815D	W3-GW-102915	W5-GW-102815	W5A-GW-102915
Sample Depth (ft)	39 - 49	39 - 49	20 - 30	999 - 999	999 - 999	999 - 999	999 - 999	999 - 999	999 - 999
Sample Date	10/22/2015	10/22/2015	10/28/2015	10/29/2015	10/28/2015	10/28/2015	10/29/2015	10/28/2015	10/29/2015
Metals (MG/L)									
Beryllium, dissolved	- -	- -	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cadmium, dissolved	- -	- -	0.0006 U	0.0006 U	**0.000797**	**0.000846**	**0.00184**	**0.000807**	0.0006 U
Cobalt, dissolved	- -	- -	**0.0272**	**0.0025**	**0.00316**	**0.0037**	**0.0158**	**0.028**	**0.00475**
Lead, dissolved	- -	- -	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Manganese, dissolved	- -	- -	**4.3**	**0.565**	**1.79**	**1.9**	**9.85**	**20.9**	**36.4**
SVOCs (µg/L)									
2-Methylnaphthalene	- -	- -	- -	- -	- -	- -	- -	- -	- -
Benzo (b) fluoranthene	- -	- -	- -	- -	- -	- -	- -	- -	- -
Bis (2-chloroethyl) ether	- -	- -	**17.6**	0.5 UL	0.515 U	0.521 U	**157**	**3.08 J**	**37.2 J**
Bis (2-chloroisopropyl) ether	- -	- -	- -	- -	- -	- -	- -	- -	- -
Bis (2-ethylhexyl) phthalate	- -	- -	- -	- -	- -	- -	- -	- -	- -
Ethyl ether	**76.2**	**75.6**	- -	- -	- -	- -	- -	- -	- -
Hexachloroethane	- -	- -	- -	- -	- -	- -	- -	- -	- -
Isophorone	- -	- -	- -	- -	- -	- -	- -	- -	- -
Naphthalene	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Phenol	- -	- -	- -	- -	- -	- -	- -	- -	- -
VOCs (µg/L)									
1,1,2,2-Tetrachloroethane	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
1,1,2-Trichloroethane	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
1,1-Dichloroethane	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
1,1-Dichloroethene	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
1,2,4-Trimethylbenzene	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
1,2-Dichloroethane	**20.7**	**20.5**	- -	- -	- -	- -	- -	- -	- -
1,2-Dichloropropane	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
1,3,5-Trimethylbenzene	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
1,3-Dichlorobenzene	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
1,4-Dichlorobenzene	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
1,4-Dioxane (p-Dioxane)	- -	- -	**34.6**	**5.89 K**	**1.19**	**1.3**	**69.5**	**10.7**	**246**
2-Butanone	5 U	5 U	- -	- -	- -	- -	- -	- -	- -
2-Hexanone	5 U	5 U	- -	- -	- -	- -	- -	- -	- -
4-Methyl-2-pentanone	5 U	5 U	- -	- -	- -	- -	- -	- -	- -
Acetone	5 UL	5 UL	- -	- -	- -	- -	- -	- -	- -
Benzene	1 U	1 U	**7.65**	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Bromomethane	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Carbon disulfide	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Carbon tetrachloride	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Chlorobenzene	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Chloroform	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Chloromethane	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
cis-1,2-Dichloroethylene	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Dibromochloromethane	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Dichlorodifluoromethane	1 UJ	1 UJ	- -	- -	- -	- -	- -	- -	- -
Ethylbenzene	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Methylene chloride	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Styrene	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Tetrachloroethene	1 U	1 U	**23.3**	1 U	1.52 B	1 U	1 U	**19.4**	5.24 B
Toluene	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Trans-1,2-Dichloroethylene	1 U	1 U	- -	- -	- -	- -	- -	- -	- -
Trichloroethylene	1 U	1 U	**5.2**	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	1 U	1 U	**53.9**	1 U	3.45 B	1.4 B	1 U	**5.82**	**1.89**
Vinyl chloride	1 U	1 U	**25.3**	1 U	1 U	1 U	1 U	1 U	1 U
Xylenes, Total	1 U	1 U	- -	- -	- -	- -	- -	- -	- -

Notes are located on page 5 of 5

Notes:
-- = Not analyzed
J = The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.
L = The analyte was positively identified, but the associated numerical value may be biased low.
U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
UJ = The analyte was below the reported sample quantitation limit. However, the reported value is approximate.
UL = The analyte was analyzed for but was not detected. The quantitation limit may be biased low.
mg/L = Milligrams per liter
µg/L = Micrograms per liter
Bold indicates the analyte was detected
ft = feet or foot
ID = identification
SVOC = semivolatile organic compound
VOC = volatile organic compound

Appendix B
Laboratory Analytical Data Reports
(presented on CD)

Appendix C
Data Quality Evaluation Report

Data Quality Evaluation, 2015 Groundwater Performance Monitoring, Institute, West Virginia

PREPARED FOR:	Union Carbide Corporation
PREPARED BY:	CH2M
DATE:	March 2016

Introduction

The objective of this data quality evaluation (DQE) report is to assess the data quality of analytical results for groundwater samples collected from the Dow West Virginia Operations (WVO) Union Carbide Corporation (UCC) Institute Facility in Institute, West Virginia. CH2M collected samples October 19 through 29, 2015 and February 16, 2016. Guidance for this DQE report came from the *Dow WVO Quality Assurance Project Plan (May 2012) (Dow WVO QAPP);* the *U.S. Environmental Protection Agency (USEPA) Contract Laboratory National Functional Guidelines for Organic Data Review, October 1999;* the *USEPA Contract Laboratory National Functional Guidelines for InOrganic Data Review, October 2004;* and, individual method requirements.

The analytical results were evaluated using the criteria of precision, accuracy, representativeness, comparability and completeness (PARCC) as presented in the Dow WVO QAPP. This report is intended as a general data quality assessment designed to summarize data issues.

Analytical Data

This DQE report covers 44 groundwater samples, 3 field duplicates (FD), 7 equipment blanks (EB) and 5 trip blanks (TB). The samples were reported in 6 sample delivery groups identified in Table 1 below.

Table 1. Sample Delivery Groups
2015 Groundwater Performance Monitoring, Institute, West Virginia

L15101181	L15101322	L15101463
L15101580	L15101755	L15101868
L16020952		

The samples were collected and delivered to Microbac Laboratories (MBLM) in Marietta, Ohio. The samples were analyzed by one or more of the methods listed in Table 2.

Table 2. Analytical Parameters
2015 Groundwater Performance Monitoring, Institute, West Virginia

Parameter	Method	Laboratory
Volatile Organic Compounds (VOC)	SW8260B	MBLM
Semivolatile Organic Compounds (SVOC)	SW8270UL	MBLM

Table 2. Analytical Parameters

2015 Groundwater Performance Monitoring, Institute, West Virginia

Parameter	Method	Laboratory
1,4-Dioxane	SW8270SIM	MBLM
Select Metals	SW6010B/SW6020	MBLM

The sample delivery groups were assessed by reviewing the following: (1) the chain of custody documentation; (2) holding-time compliance; (3) initial and continuing calibration criteria; (4) method blanks/field blanks; (5) laboratory control spiking sample/laboratory control spiking sample duplicate (LCS/LCSD) recoveries and precision; (6) matrix spike/matrix spike duplicate (MS/MSD) recoveries and precision; (7) surrogate spike recoveries; (8) internal standard (IS) recoveries; and, (9) the required quality control (QC) samples at the specified frequencies.

Data flags were assigned according to the Dow WVO QAPP. Multiple flags are routinely applied to specific sample method/matrix/analyte combinations, but there will only be one final flag. A final flag is applied to the data and is the most conservative of the applied validation flags. The final flag also includes matrix and blank sample impacts.

The data flags are those listed in the Dow WVO QAPP and are defined below:

- J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- R = The sample result was rejected due to serious deficiencies in the ability to analyze the sample and meet the QC criteria. The presence or absence of the analyte could not be verified.
- U = The analyte was analyzed for but was not detected above the reported sample quantitation limit.
- UJ = The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- B = The analyte was detected in the blank as well as the samples.
- K = The analyte was positively identified, but the associated numerical value may be biased high.
- L = The analyte was positively identified, but the associated numerical value may be biased low.
- UL = The analyte was analyzed for but was not detected. The quantitation limit may be biased low.

Findings

The overall summaries of the data validation are contained in the following sections. Qualified data are listed in Table 2.

Holding Time/Preservation

All acceptance criteria were met.

Calibration

Initial and continuing calibration analyses were performed as required by the method and all acceptance criteria were met with the following exceptions:

The relative response factor (RRF) for acetone was less than criteria in several VOC initial calibrations, initial calibration verification standards (ICVS) and continuing calibration verification standards (CCV), indicating a possible low bias. The data were qualified as estimated detected and non-detected results and flagged "L" and "UL", respectively, in the associated samples.

The percent differences (%D) for carbon disulfide and trichlorofluoromethane were less than criteria in one VOC ICVS, indicating a possible low bias. The data were qualified as estimated detected and non-detected results and flagged "J" and "UJ", respectively, in the associated samples.

The %Ds for carbon disulfide and dichlorodifluoromethane were less than criteria in a few VOC CCVs, indicating a possible low bias. The data were qualified as estimated detected and non-detected results and flagged "J" and "UJ", respectively, in the associated samples. In addition, the %Ds for bromomethane and chloromethane were greater than criteria in a few CCVs, indicating a possible high bias. The data were not qualified because the associated samples did not contain reportable levels of these analytes.

Trichlorofluoromethane exceeded the calibration range of the instrument in sample TW46-GW-102315. The result was qualified as estimated and flagged "J" in the sample.

Method Blanks

Method blanks were analyzed at the required frequency and were free of contamination.

Laboratory Control Samples

LCS/LCSDs were analyzed as required and accuracy and precision criteria were met with the following exceptions:

Carbon disulfide was recovered less than the lower control limit in a few VOC LCS/LCSDs, indicating a possible low bias. The data were qualified as estimated detected and non-detected results and flagged "L" and "UL", respectively, in the associated samples. In addition, chloromethane was recovered greater than the upper control limit in a few LCS/LCSDs, indicating a possible high bias. The data were not qualified because the associated samples did not contain reportable levels of chloromethane.

Internal Standards

ISs were added to the samples and acceptance criteria were met.

Surrogates

Surrogates were added to the samples and acceptance criteria were met with the following exceptions:

Two or more surrogates associated with the base fraction of the SVOC analysis were recovered less than the lower control limits in several samples, indicating a possible low bias. The associated data were qualified as estimated detected and non-detected results and flagged "L" and "UL", respectively, in the samples. In addition, two or more surrogates associated with the acid fraction of the SVOC analysis were recovered greater than the upper control limit in samples MW103-GW-102015 and TW52B-GW-102115, indicating a possible high bias. The data were not qualified because the samples did not contain reportable levels of the analytes associated with the acid fraction.

One surrogate associated with the base fraction of the SVOC analysis was recovered greater than the upper control limit in samples W5-GW-102815 and W5A-GW-102915, indicating a possible high bias. As bis(2-chloroethyl)ether was the only analyte reported for these samples, the analyte was qualified as estimated and flagged "J".

Matrix Spike Samples

MS/MSDs were analyzed as required and accuracy and precision criteria were met with the following exceptions:

Carbon disulfide was recovered less than the lower control limit in the VOC MS for sample MW103-GW-102015, indicating a possible low bias. The result was qualified as an estimated non-detect and flagged "UL" in the parent sample. In addition, chloromethane was recovered greater than the upper control limit in the MS/MSD, indicating a possible high bias. The result was not qualified because the sample did not contain reportable levels of chloromethane.

Isophorone was recovered less than the lower control limit in the SVOC MS for sample TW60B-GW-101915, indicating a possible low bias. The result was qualified as an estimated non-detect and flagged "UL" in the parent sample.

A few analytes were recovered greater than the upper control limits in the SVOC MS/MSD for sample MW103-GW-102015, indicating a possible high bias. Detected results were qualified as estimated and flagged "K" in the parent sample. Non-detects were not qualified.

The recovery of 1,4-dioxane was less than the lower control limits in the MS/MSDs for samples TW60B-GW-101915 and MW103-GW-102015, indicating a possible low bias. The data were qualified as estimated detected results and flagged "L" in the respective parent sample.

The recovery of 1,4-dioxane was greater than the upper control limit in the MSD for sample W10A-GW-102915, indicating a possible high bias. The result was qualified as estimated and flagged "K" in the parent sample.

The relative percent difference (RPD) for several analytes exceeded criteria in a few SVOC MS/MSDs. Detected results were qualified as estimated and flagged "J" in the respective parent sample. Non-detected results were not qualified.

The RPD for 1,4-dioxane exceeded criteria in a few MS/MSDs. The data were qualified as estimated and flagged "J" in the respective parent samples.

Field Blanks

EBs and TBs were collected, analyzed and were free of contamination with the following exceptions:

Chloroform, carbon tetrachloride, tetrachloroethene and trichlorofluoromethane were detected at concentrations greater than the reporting limit (RL) in several VOC EBs. The data were qualified as estimated non-detects and flagged "B" when the associated sample concentrations were less than five times the blank concentrations.

Manganese and 1,4-dioxane were detected at concentrations greater than the RL in one EB; however, the associated samples were not impacted.

Field Duplicates

FDs were collected, analyzed and all precision criteria were met with the following exceptions:

The RPD for carbon disulfide exceeded criteria in FD pair TW56-GW-102315/ TW56-GW-102315D. The data were qualified as estimated and flagged "J" in the FD pair.

The RPD for trichlorofluoromethane exceeded criteria in FD pair W14-GW-102815/ W14-GW-102815D. The data were qualified as estimated and flagged "J" in the FD pair.

Chain of Custody

Required procedures were followed and were generally free of errors.

Overall Assessment

The goal of this assessment is to demonstrate that a sufficient number of representative samples were collected and the resulting analytical data can be used to support the decision- making process. The following summary highlights the PARCC findings for the above-defined events:

Precision of the data was verified through the review of the laboratory data quality indicators that include FD, LCS/LCSD and MS/MSD RPDs. Precision was generally acceptable with the exception of a few analytes being qualified as estimated due to FD and MS/MSD RPD issues. Data users should consider the impact to any result that is qualified as it may contain a bias which could affect the decision-making process

Accuracy of the data was verified through the review of the calibration data, LCS/LCSD, MS/MSD, internal standards, and surrogate standard recoveries, as well as the evaluation of method/field blank data. Accuracy was generally acceptable with the exception of a few analytes being qualified as estimated detected and non-detected results due to calibration, LCS/LCSD, MS/MSD and/or surrogate issues. A few VOC analytes were qualified as not detected due to equipment blank contamination in several samples. All method blanks were free of contamination.

Representativeness of the data was verified through the sample's collection, storage and preservation procedures and the verification of holding-time compliance. The laboratory did not note any issues related to sample preservation or storage of the samples. The data were reported from analyses within the USEPA recommended holding time.

Comparability of the data was verified through the use of standard USEPA analytical procedures and standard units for reporting. Results obtained are comparable to industry standards in that the collection and analytical techniques followed approved, documented procedures.

Completeness is a measure of the number of valid measurements obtained in relation to the total number of measurements planned. Completeness is expressed as the percentage of valid or usable measurements compared to planned measurements. Valid data are defined as all data that are not rejected for project use. All data were considered valid. The completeness goal of 90 percent was met for all method/analytes combinations. The data can be used for project decisions taking into consideration the validation flags applied to the data.

Table 2. Qualified Data
2015 Groundwater Performance Monitoring, Institute, West Virginia

NativeID	Method	Analyte	Units	Final Result	Validation Flag	Validation Reason
ENBNI4-GW-102215	SW8260B	Acetone	ug/L	350	L	IC RRF, ICVS RRF, CCV RRF
ENBNI4-GW-102215	SW8260B	Dichlorodifluoromethane	ug/L	34.6	J	CCV<LCL
ENBNI4-GW-102215	SW8260B	Trichlorofluoromethane	ug/L	4950	J	ICVS<LCL
MW102-GW-102015	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
MW102-GW-102015	SW8260B	Carbon Disulfide	ug/L	1	UJ	ICVS<LCL, CCV<LCL
MW102-GW-102015	SW8260B	Trichlorofluoromethane	ug/L	1	UJ	ICVS<LCL
MW103-GW-102015	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
MW103-GW-102015	SW8260B	Carbon Disulfide	ug/L	1	UL	MS<LCL, ICVS<LCL (UJ), CCV<LCL (UJ)
MW103-GW-102015	SW8260B	Trichlorofluoromethane	ug/L	1	UJ	ICVS<LCL
MW103-GW-102015	SW8270CSIM	1,4-Dioxane	ug/L	14.4	L	MS<LCL
MW103-GW-102015	SW8270UL	Naphthalene	ug/L	1.66	K	SD>UCL, MSRPD (J)
TW26-GW-101915	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
TW42-GW-102215	SW8260B	Acetone	ug/L	250	UL	IC RRF, ICVS RRF, CCV RRF
TW42-GW-102215	SW8260B	Dichlorodifluoromethane	ug/L	50	UJ	CCV<LCL
TW45-GW-102215	SW8260B	Acetone	ug/L	28.9	L	IC RRF, ICVS RRF, CCV RRF
TW45-GW-102215	SW8260B	Carbon Disulfide	ug/L	5	UL	LCS<LCL, LCSD<LCL, ICVS<LCL (UJ), CCV<LCL (UJ)
TW45-GW-102215	SW8260B	Trichlorofluoromethane	ug/L	10.9	J	ICVS<LCL
TW46-GW-102315	SW8260B	Acetone	ug/L	100	UL	IC RRF, ICVS RRF, CCV RRF
TW46-GW-102315	SW8260B	Carbon Disulfide	ug/L	20	UL	LCS<LCL, LCSD<LCL, ICVS<LCL (UJ), CCV<LCL (UJ)
TW46-GW-102315	SW8260B	Trichlorofluoromethane	ug/L	3460	J	>ICLinearRange
TW52A-GW-102015	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
TW52A-GW-102015	SW8260B	Carbon Disulfide	ug/L	1	UJ	ICVS<LCL, CCV<LCL
TW52A-GW-102015	SW8260B	Trichlorofluoromethane	ug/L	1	UJ	ICVS<LCL
TW52B-GW-102115	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
TW52B-GW-102115	SW8260B	Carbon Disulfide	ug/L	1	UJ	ICVS<LCL, CCV<LCL
TW52B-GW-102115	SW8260B	Trichlorofluoromethane	ug/L	1	UJ	ICVS<LCL
TW53-GW-102215	SW8260B	Acetone	ug/L	25	UL	IC RRF, ICVS RRF, CCV RRF
TW53-GW-102215	SW8260B	Carbon Disulfide	ug/L	5	UL	LCS<LCL, LCSD<LCL, ICVS<LCL (UJ), CCV<LCL (UJ)
TW53-GW-102215	SW8260B	Trichlorofluoromethane	ug/L	9.44	J	ICVS<LCL
TW54A-GW-102215	SW8260B	Acetone	ug/L	100	UL	IC RRF, ICVS RRF, CCV RRF
TW54A-GW-102215	SW8260B	Dichlorodifluoromethane	ug/L	20	UJ	CCV<LCL
TW54B-GW-102315	SW8260B	Acetone	ug/L	25	UL	IC RRF, ICVS RRF, CCV RRF
TW54B-GW-102315	SW8260B	Dichlorodifluoromethane	ug/L	42.9	J	CCV<LCL

Table 2. Qualified Data
2015 Groundwater Performance Monitoring, Institute, West Virginia

NativeID	Method	Analyte	Units	Final Result	Validation Flag	Validation Reason
TW54B-GW-102315	SW8260B	Trichlorofluoromethane	ug/L	2140	J	ICVS<LCL
TW55-GW-102115	SW8260B	Acetone	ug/L	25	UL	IC RRF, ICVS RRF, CCV RRF
TW55-GW-102115	SW8260B	Carbon Disulfide	ug/L	5	UJ	ICVS<LCL, CCV<LCL
TW55-GW-102115	SW8260B	Trichlorofluoromethane	ug/L	456	J	ICVS<LCL
TW56-GW-102315	SW8260B	Acetone	ug/L	1250	UL	IC RRF, ICVS RRF, CCV RRF
TW56-GW-102315	SW8260B	Carbon Disulfide	ug/L	920	L	LCS<LCL, LCSD<LCL, ICVS<LCL (J), CCV<LCL (J), FD>RPD (J)
TW56-GW-102315	SW8260B	Trichlorofluoromethane	ug/L	25700	J	ICVS<LCL
TW56-GW-102315D	SW8260B	Acetone	ug/L	1250	UL	IC RRF, ICVS RRF, CCV RRF
TW56-GW-102315D	SW8260B	Carbon Disulfide	ug/L	381	L	LCS<LCL, LCSD<LCL, ICVS<LCL (J), CCV<LCL (J), FD>RPD (J)
TW56-GW-102315D	SW8260B	Trichlorofluoromethane	ug/L	25600	J	ICVS<LCL
TW57-GW-102315	SW8260B	Acetone	ug/L	500	UL	IC RRF, ICVS RRF, CCV RRF
TW57-GW-102315	SW8260B	Carbon Disulfide	ug/L	100	UL	LCS<LCL, LCSD<LCL, ICVS<LCL (UJ), CCV<LCL (UJ)
TW57-GW-102315	SW8260B	Trichlorofluoromethane	ug/L	7720	J	ICVS<LCL
TW58-GW-101915	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
TW59A-GW-102115	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
TW59A-GW-102115	SW8260B	Carbon Disulfide	ug/L	1	UJ	ICVS<LCL, CCV<LCL
TW59A-GW-102115	SW8260B	Trichlorofluoromethane	ug/L	1	UJ	ICVS<LCL
TW59B-GW-102215	SW8260B	Acetone	ug/L	12.5	UL	IC RRF, ICVS RRF, CCV RRF
TW59B-GW-102215	SW8260B	Dichlorodifluoromethane	ug/L	7.01	J	CCV<LCL
TW60A-GW-102115	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
TW60A-GW-102115	SW8260B	Carbon Disulfide	ug/L	1	UJ	ICVS<LCL, CCV<LCL
TW60A-GW-102115	SW8260B	Trichlorofluoromethane	ug/L	1	UJ	ICVS<LCL
TW60B-GW-101915	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
TW60B-GW-101915	SW8270CSIM	1,4-Dioxane	ug/L	3.87	L	MS<LCL, SD<LCL, MSRPD (J)
TW60B-GW-101915	SW8270UL	Isophorone	ug/L	0.595	UL	MS<LCL
TW61-GW-102115	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
TW61-GW-102115	SW8260B	Carbon Disulfide	ug/L	1	UJ	ICVS<LCL, CCV<LCL
TW61-GW-102115	SW8260B	Trichlorofluoromethane	ug/L	83.4	J	ICVS<LCL
TW62A-GW-102115	SW8260B	Acetone	ug/L	12.2	L	IC RRF, ICVS RRF, CCV RRF
TW62A-GW-102115	SW8260B	Carbon Disulfide	ug/L	1	UJ	ICVS<LCL, CCV<LCL
TW62A-GW-102115	SW8260B	Trichlorofluoromethane	ug/L	1	UJ	ICVS<LCL

Table 2. Qualified Data
2015 Groundwater Performance Monitoring, Institute, West Virginia

NativeID	Method	Analyte	Units	Final Result	Validation Flag	Validation Reason
TW62B-GW-102115	SW8260B	Acetone	ug/L	50	UL	IC RRF, ICVS RRF, CCV RRF
TW62B-GW-102115	SW8260B	Carbon Disulfide	ug/L	44	J	ICVS<LCL, CCV<LCL
TW62B-GW-102115	SW8260B	Trichlorofluoromethane	ug/L	10	UJ	ICVS<LCL
TW63A-GW-101915	SW8260B	Acetone	ug/L	250	UL	IC RRF, ICVS RRF, CCV RRF
TW63A-GW-101915	SW8270UL	2-Methylnaphthalene	ug/L	0.575	UL	Sur<LCL
TW63A-GW-101915	SW8270UL	Benzo (b) fluoranthene	ug/L	0.575	UL	Sur<LCL
TW63A-GW-101915	SW8270UL	Bis (2-chloroethyl) ether	ug/L	0.575	UL	Sur<LCL
TW63A-GW-101915	SW8270UL	Bis (2-chloroisopropyl) ether	ug/L	0.575	UL	Sur<LCL
TW63A-GW-101915	SW8270UL	Bis (2-ethylhexyl) phthalate	ug/L	5.75	UL	Sur<LCL
TW63A-GW-101915	SW8270UL	Hexachloroethane	ug/L	0.575	UL	Sur<LCL
TW63A-GW-101915	SW8270UL	Isophorone	ug/L	0.596	L	Sur<LCL
TW63A-GW-101915	SW8270UL	Naphthalene	ug/L	13.4	L	Sur<LCL
TW63B-GW-101915	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
TW63B-GW-101915	SW8270UL	2-Methylnaphthalene	ug/L	0.562	UL	Sur<LCL
TW63B-GW-101915	SW8270UL	Benzo (b) fluoranthene	ug/L	0.562	UL	Sur<LCL
TW63B-GW-101915	SW8270UL	Bis (2-chloroethyl) ether	ug/L	0.562	UL	Sur<LCL
TW63B-GW-101915	SW8270UL	Bis (2-chloroisopropyl) ether	ug/L	0.562	UL	Sur<LCL
TW63B-GW-101915	SW8270UL	Bis (2-ethylhexyl) phthalate	ug/L	5.62	UL	Sur<LCL
TW63B-GW-101915	SW8270UL	Hexachloroethane	ug/L	0.562	UL	Sur<LCL
TW63B-GW-101915	SW8270UL	Isophorone	ug/L	0.562	UL	Sur<LCL
TW63B-GW-101915	SW8270UL	Naphthalene	ug/L	0.562	UL	Sur<LCL
TW65A-GW-102015	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
TW65A-GW-102015	SW8260B	Carbon Disulfide	ug/L	1	UJ	ICVS<LCL, CCV<LCL
TW65A-GW-102015	SW8260B	Trichlorofluoromethane	ug/L	1	UJ	ICVS<LCL
TW65B-GW-102015	SW8260B	Acetone	ug/L	36	L	IC RRF, ICVS RRF, CCV RRF
TW65B-GW-102015	SW8260B	Carbon Disulfide	ug/L	1	UJ	ICVS<LCL, CCV<LCL
TW65B-GW-102015	SW8260B	Trichlorofluoromethane	ug/L	1	UJ	ICVS<LCL
TW66B-GW-102015	SW8260B	Acetone	ug/L	1250	UL	IC RRF, ICVS RRF, CCV RRF
TW66B-GW-102015	SW8260B	Carbon Disulfide	ug/L	733	J	ICVS<LCL, CCV<LCL
TW66B-GW-102015	SW8260B	Trichlorofluoromethane	ug/L	250	UJ	ICVS<LCL
TW67B-GW-101915	SW8260B	Acetone	ug/L	500	UL	IC RRF, ICVS RRF, CCV RRF
TW69A-GW-102315	SW8260B	Acetone	ug/L	250	UL	IC RRF, ICVS RRF, CCV RRF
TW69A-GW-102315	SW8260B	Carbon Disulfide	ug/L	50	UL	LCS<LCL, LCSD<LCL, ICVS<LCL (UJ), CCV<LCL (UJ)
TW69A-GW-102315	SW8260B	Trichlorofluoromethane	ug/L	3200	J	ICVS<LCL
TW70B-GW-102315	SW8260B	Acetone	ug/L	250	UL	IC RRF, ICVS RRF, CCV RRF
TW70B-GW-102315	SW8260B	Carbon Disulfide	ug/L	156	L	LCS<LCL, ICVS<LCL (J), CCV<LCL (J)
TW70B-GW-102315	SW8260B	Trichlorofluoromethane	ug/L	6120	J	ICVS<LCL

Table 2. Qualified Data
2015 Groundwater Performance Monitoring, Institute, West Virginia

NativeID	Method	Analyte	Units	Final Result	Validation Flag	Validation Reason
TW71A-GW-102615	SW8260B	Acetone	ug/L	12.5	UL	IC RRF, ICVS RRF, CCV RRF
TW71A-GW-102615	SW8260B	Carbon Disulfide	ug/L	2.5	UL	LCS<LCL, ICVS<LCL (UJ), CCV<LCL (UJ)
TW71A-GW-102615	SW8260B	Trichlorofluoromethane	ug/L	2.5	UJ	ICVS<LCL
TW71B-GW-102615	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
TW71B-GW-102615	SW8260B	Carbon Disulfide	ug/L	1	UL	LCS<LCL, LCSD<LCL, ICVS<LCL (UJ), CCV<LCL (UJ)
TW71B-GW-102615	SW8260B	Chloroform	ug/L	2.44	B	EB>RL
TW71B-GW-102615	SW8260B	Trichlorofluoromethane	ug/L	1	UJ	ICVS<LCL
VW15A-GW-102115	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
VW15A-GW-102115	SW8260B	Carbon Disulfide	ug/L	1	UJ	ICVS<LCL, CCV<LCL
VW15A-GW-102115	SW8260B	Trichlorofluoromethane	ug/L	1	UJ	ICVS<LCL
VW15B-GW-102215	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
VW15B-GW-102215	SW8260B	Dichlorodifluoromethane	ug/L	1	UJ	CCV<LCL
VW15B-GW-102215D	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
VW15B-GW-102215D	SW8260B	Dichlorodifluoromethane	ug/L	1	UJ	CCV<LCL
VW3A-GW-101915	SW8260B	Acetone	ug/L	5	UL	IC RRF, ICVS RRF, CCV RRF
VW3B-GW-102115	SW8260B	Acetone	ug/L	14.4	L	IC RRF, ICVS RRF, CCV RRF
VW3B-GW-102115	SW8260B	Carbon Disulfide	ug/L	1	UJ	ICVS<LCL, CCV<LCL
VW3B-GW-102115	SW8260B	Trichlorofluoromethane	ug/L	41.9	J	ICVS<LCL
W10A-GW-102915	SW8270CSIM	1,4-Dioxane	ug/L	5.89	K	SD>UCL, MSRPD (J)
W10A-GW-102915	SW8270UL	Bis (2-chloroethyl) ether	ug/L	0.5	UL	Sur<LCL
W14-GW-102815	SW8260B	Tetrachloroethene	ug/L	1.52	B	EB>RL
W14-GW-102815	SW8260B	Trichlorofluoromethane	ug/L	3.45	B	EB>RL, FD>RPD (J)
W14-GW-102815D	SW8260B	Trichlorofluoromethane	ug/L	1.4	B	EB>RL, FD>RPD (J)
W5A-GW-102915	SW8260B	Tetrachloroethene	ug/L	5.24	B	EB>RL
W5A-GW-102915	SW8270UL	Bis (2-chloroethyl) ether	ug/L	37.2	J	Sur>UCL
W5-GW-102815	SW8270UL	Bis (2-chloroethyl) ether	ug/L	3.08	J	Sur>UCL
TW64-GW-021616	SW8260B	Acetone	ug/L	25	UL	IC RRF, ICVS RRF, CCV RRF

Validation Reasons:

>ICLinearRange	The analyte concentration exceeded the calibration range of the instrument
CCV RRF	The continuing calibration verification relative response factor was less than criteria
CCV<LCL	The continuing calibration verification was recovered less than criteria
EB>RL	The analyte was detected in the equipment blank at a concentration greater than the reporting limit
FD>RPD	The relative percent difference exceeded criteria in the field duplicate pair
IC RRF	The initial calibration relative response factor was less than criteria
ICVS RRF	The initial calibration verification standard relative response factor was less than criteria
ICVS<LCL	The initlal calibration verification was recovered less than criteria
LCS<LCL	The laboratory control sample was recovered less than criteria
LCSD<LCL	The laboratory control sample duplicate was recovered less than criteria

Table 2. Qualified Data

2015 Groundwater Performance Monitoring, Institute, West Virginia

NativeID	Method	Analyte	Units	Final Result	Validation Flag	Validation Reason
MS<LCL	The matrix spike sample was recovered less than the lower control limit					
MSRPD	The relative percent difference exceeded criteria between the MS and MSD					
SD<LCL	The matrix spike sample duplicate was recovered less than the lower control limit					
SD>UCL	The matrix spike sample duplicate was recovered greater than the upper control limit					
Sur<LCL	The surrogate was recovered less than the lower control limit					
Sur>UCL	The surrogate was recovered greater than the upper control limit					

References

CH2M. 2012. *Dow WVO Quality Assurance Project Plan*. Prepared for Union Carbide Corporation. May.

USEPA. 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*. OSWER 9240.1-05A-P. EPA540/R-99/008.

USEPA. 2004. *USEPA Contract Laboratory Program National Functional Guidelines for InOrganic Data Review*. OSWER 9240.1-45. EPA540/R-04/004.

Appendix D
Results of Performance Standard 1: Onsite Containment (Screened Summary Tables)

Table D-1. Perimeter Monitoring Wells Adjacent to Offsite Property Screened Against Human Health Screening Levels

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Analyte	Location	TW-60A	TW-60B	TW-65A	TW-65B	VW-03A	VW-03B	VW-15A	VW-15B		W-10A
	Sample ID	TW60A-GW-102115	TW60B-GW-101915	TW65A-GW-102015	TW65B-GW-102015	VW3A-GW-101915	VW3B-GW-102115	VW15A-GW-102115	VW15B-GW-102215	VW15B-GW-102215D	W10A-GW-102915
	Sample Depth (ft)	16 - 26	32 - 42	15 - 25	45 - 55	21 - 31	42 - 52	20 - 30	39 - 49	39 - 49	999 - 999
	Sample Date	10/21/2015	10/19/2015	10/20/2015	10/20/2015	10/19/2015	10/21/2015	10/21/2015	10/22/2015	10/22/2015	10/29/2015
	Screening Level										
Metals (MG/L)											
Beryllium, dissolved	--**	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.002 U
Cadmium, dissolved	--**	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.0006 U
Cobalt, dissolved	--**	- -	- -	- -	- -	- -	- -	- -	- -	- -	**0.0025**
Lead, dissolved	--**	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.001 U
Manganese, dissolved	--**	- -	- -	- -	- -	- -	- -	- -	- -	- -	**0.565**
SVOCs (ug/L)											
2-Methylnaphthalene	3.6	0.526 U	0.595 U	- -	0.532 U	- -	- -	- -	- -	- -	- -
Benzo (b) fluoranthene	0.034	0.526 U	0.595 U	- -	0.532 U	- -	- -	- -	- -	- -	- -
Bis (2-chloroethyl) ether	0.014	0.526 U	0.595 U	- -	0.532 U	- -	- -	- -	- -	- -	0.5 UL
Bis (2-chloroisopropyl) ether	71	0.526 U	0.595 U	- -	0.532 U	- -	- -	- -	- -	- -	- -
Bis (2-ethylhexyl) phthalate	6	5.26 U	5.95 U	- -	5.32 U	- -	- -	- -	- -	- -	- -
Ethyl ether	390	10 U	10 U	10 U	10 U	10 U	10 U	10 U	**76.2**	**75.6**	- -
Hexachloroethane	0.33	0.526 U	0.595 U	- -	0.532 U	- -	- -	- -	- -	- -	- -
Isophorone	78	0.526 U	0.595 UL	- -	0.532 U	- -	- -	- -	- -	- -	- -
Naphthalene	0.17	0.526 U	0.595 U	1 U	0.532 U	1 U	1 U	1 U	1 U	1 U	- -
Phenol	580	0.526 U	0.595 U	- -	0.532 U	- -	- -	- -	- -	- -	- -
VOCs (ug/L)											
1,1,2,2-Tetrachloroethane	0.076	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
1,1,2-Trichloroethane	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
1,1-Dichloroethane	2.8	1 U	1 U	**6.23**	**1.85**	1 U	1 U	1 U	1 U	1 U	- -
1,1-Dichloroethene	7	1 U	1 U	**1.82**	1 U	1 U	1 U	1 U	1 U	1 U	- -
1,2,4-Trimethylbenzene	1.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
1,2-Dichloroethane	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**20.7**	**20.5**	- -
1,2-Dichloropropane	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
1,3,5-Trimethylbenzene	12	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
1,3-Dichlorobenzene	--	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
1,4-Dichlorobenzene	75	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
1,4-Dioxane (p-Dioxane)	0.46	**15.8**	**3.87 L**	- -	**19.5**	- -	- -	- -	- -	- -	**5.89 K**
2-Butanone	560	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	- -
2-Hexanone	3.8	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	- -
4-Methyl-2-pentanone	630	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	- -
Acetone	1400	5 UL	5 UL	5 UL	**36 L**	5 UL	**14.4 L**	5 UL	5 UL	5 UL	- -
Benzene	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	80	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
Bromomethane	0.75	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
Carbon disulfide	81	1 UJ	1 U	1 UJ	1 UJ	1 U	1 UJ	1 UJ	1 U	1 U	- -
Carbon tetrachloride	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
Chlorobenzene	100	1 U	1 U	1 U	1 U	1 U	**1.84**	1 U	1 U	1 U	- -
Chloroform	80	1 U	1 U	1 U	1 U	1 U	**3.67**	1 U	1 U	1 U	- -
Chloromethane	19	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
cis-1,2-Dichloroethylene	70	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
Dibromochloromethane	80	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
Dichlorodifluoromethane	20	1 U	1 U	1 U	1 U	1 U	**12.8**	1 U	1 UJ	1 UJ	- -
Ethylbenzene	700	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
Methylene chloride	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
Styrene	100	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
Tetrachloroethene	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1000	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
Trans-1,2-Dichloroethylene	100	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -
Trichloroethylene	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	520	1 UJ	1 U	1 UJ	1 UJ	1 U	**41.9 J**	1 UJ	1 U	1 U	1 U
Vinyl chloride	2	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Xylenes, Total	10000	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	- -

Notes are located on page 2 of 2

Notes:
NA = Not analyzed
B = The analyte was detected in the associated method and/or calibration blank.
J = The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample
K = The analyte was positively identified, but the associated numerical value may be biased high.
L = The analyte was positively identified, but the associated numerical value may be biased low.
U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
UJ = The analyte was below the reported sample quantitation limit. However, the reported value is approximate.
UL = The analyte was analyzed for but was not detected. The quantitation limit may be biased low.
mg/l = Milligrams per Liter
µg/L = Micrograms per Liter
Bold indicates the analyte was detected
Shading indicates the result exceeded screening criteria
* The screening level is the United States Environmental Protection Agency's Maximum Contaminant Level (MCL) or tap water Regional Screening Level (RSL; USEPA 2015
** Metals were not retained as WWTU area COCs as noted in the *Groundwater to Surface Water and Sediment Risk Evaluation for Metals* report (CH2M HILL 2014).
ft = feet
ID = identification
SVOC = semivolatile organic compounds
VOC = volatile organic compounds

Table D-2. Monitoring Wells Screened Against Site-Specific Groundwater Screening Levels or Ecological Screening Levels

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Analyte	Location	MW-102	MW-103	TW-63A	TW-63B	TW-64	TW-66B	TW-67B	VW-03A	VW-03B	VW-15A	VW-15B		W-3	W-5	W-5A	W-14	
	Sample ID	MW102-GW-102015	MW103-GW-102015	TW63A-GW-101915	TW63B-GW-101915	TW64-GW-021616	TW66B-GW-102015	TW67B-GW-101915	VW3A-GW-101915	VW3B-GW-102115	VW15A-GW-102115	VW15B-GW-102215	VW15B-GW-102215D	W3-GW-102915	W5-GW-102815	W5A-GW-102915	W14-GW-102815	W14-GW-102815D
	Sample Depth (ft)	23 - 33	41 - 51	23 - 33	37 - 47	41 - 51	33 - 43	40.5 - 50.5	21 - 31	42 - 52	20 - 30	39 - 49	39 - 49	999 - 999	999 - 999	999 - 999	999 - 999	999 - 999
	Sample Date	10/20/2015	10/20/2015	10/19/2015	10/19/2015	2/16/2016	10/20/2015	10/19/2015	10/19/2015	10/21/2015	10/21/2015	10/22/2015	10/22/2015	10/29/2015	10/28/2015	10/29/2015	10/28/2015	10/28/2015
	Screening Level																	
Metals (MG/L)																		
Beryllium, dissolved	--**	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cadmium, dissolved	--**	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	**0.00184**	**0.000807**	0.0006 U	**0.000797**	**0.000846**
Cobalt, dissolved	--**	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	**0.0158**	**0.028**	**0.00475**	**0.00316**	**0.0037**
Lead, dissolved	--**	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Manganese, dissolved	--**	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	**9.85**	**20.9**	**36.4**	**1.79**	**1.9**
SVOCs (ug/L)																		
2-Methylnaphthalene	72.16	0.556 U	0.51 U	0.575 UL	0.562 UL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Benzo (b) fluoranthene	--	0.556 U	0.51 U	0.575 UL	0.562 UL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Bis (2-chloroethyl) ether	1892.1	0.556 U	**2.28**	0.575 UL	0.562 UL	- -	- -	- -	- -	- -	- -	- -	- -	**157**	**3.08 J**	**37.2 J**	0.515 U	0.521 U
Bis (2-chloroisopropyl) ether	297	0.556 U	**1.7**	0.575 UL	0.562 UL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Bis (2-ethylhexyl) phthalate	16	5.56 U	5.1 U	5.75 UL	5.62 UL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Ethyl ether	--	10 U	**418**	500 U	**75.4**	**1200**	2500 U	1000 U	10 U	10 U	10 U	**76.2**	**75.6**	- -	- -	- -	- -	- -
Hexachloroethane	12	0.556 U	0.51 U	0.575 UL	0.562 UL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Isophorone	9230	0.556 U	0.51 U	**0.596 L**	0.562 UL	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Naphthalene	193	**1.46**	**4.92**	**134**	**4.32**	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
Phenol	2560	**6.83**	0.51 U	**200**	**3.4**	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
VOCs (ug/L)																		
1,1,2,2-Tetrachloroethane	610	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
1,1,2-Trichloroethane	1200	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
1,1-Dichloroethane	47	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
1,1-Dichloroethene	25	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
1,2,4-Trimethylbenzene	33	**1.84**	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
1,2-Dichloroethane	100	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	**20.7**	**20.5**	- -	- -	- -	- -	- -
1,2-Dichloropropane	--	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
1,3,5-Trimethylbenzene	71	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
1,3-Dichlorobenzene	150	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
1,4-Dichlorobenzene	26	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
1,4-Dioxane (p-Dioxane)	22740	1.11 U	**14.4 L**	1.15 U	**5.77**	- -	- -	- -	- -	- -	- -	- -	- -	**69.5**	**10.7**	**246**	**1.19**	**1.3**
2-Butanone	14000	5 U	5 U	250 U	5 U	25 U	1250 U	500 U	5 U	5 U	5 U	5 U	5 U	- -	- -	- -	- -	- -
2-Hexanone	99	5 U	5 U	250 U	5 U	25 U	1250 U	500 U	5 U	5 U	5 U	5 U	5 U	- -	- -	- -	- -	- -
4-Methyl-2-pentanone	170	5 U	5 U	250 U	5 U	25 U	1250 U	500 U	5 U	5 U	5 U	5 U	5 U	- -	- -	- -	- -	- -
Acetone	1500	5 UL	5 UL	250 UL	5 UL	25 UL	1250 UL	500 UL	5 UL	**14.4 L**	5 UL	5 UL	5 UL	- -	- -	- -	- -	- -
Benzene	130	**142**	1 U	**23000**	**37.6**	5 U	**104000**	**44300**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	--	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
Bromomethane	--	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
Carbon disulfide	105	1 UJ	1 UL	50 U	1 U	5 U	**733 J**	100 U	1 U	1 UJ	1 UJ	1 U	1 U	- -	- -	- -	- -	- -
Carbon tetrachloride	13.3	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
Chlorobenzene	64	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	**1.84**	1 U	1 U	1 U	- -	- -	- -	- -	- -
Chloroform	3400	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	**3.67**	1 U	1 U	1 U	- -	- -	- -	- -	- -
Chloromethane	--	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
cis-1,2-Dichloroethylene	--	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
Dibromochloromethane	--	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
Dichlorodifluoromethane	7522	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	**12.8**	1 U	1 UJ	1 UJ	- -	- -	- -	- -	- -
Ethylbenzene	7.3	1 U	1 U	**1610**	**24.9**	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
Methylene chloride	98.1	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
Styrene	72	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
Tetrachloroethene	111	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	1 U	**19.4**	5.24 B	1.52 B	1 U
Toluene	9.8	**1.11**	1 U	**190**	**1.26**	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
Trans-1,2-Dichloroethylene	--	1 U	1 U	50 U	1 U	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -
Trichloroethylene	21	1 U	1 U	50 U	1 U	5 U	250 U	500 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	5008	1 UJ	1 UJ	50 U	1 U	5 U	250 UJ	100 U	1 U	**41.9 J**	1 UJ	1 U	1 U	1 U	**5.82**	**1.89**	3.45 B	1.4 B
Vinyl chloride	930	1 U	1 U	50 U	1 U	**9.52**	250 U	100 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Xylenes, Total	67	**27.5**	1 U	**327**	**9.63**	5 U	250 U	100 U	1 U	1 U	1 U	1 U	1 U	- -	- -	- -	- -	- -

Notes are located on page 2 of 2

Notes:
NA = Not analyzed
B = The analyte was detected in the associated method and/or calibration blank.
J = The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.
K = The analyte was positively identified, but the associated numerical value may be biased high.
L = The analyte was positively identified, but the associated numerical value may be biased low.
U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
UJ = The analyte was below the reported sample quantitation limit. However, the reported value is approximate.
UL = The analyte was analyzed for but was not detected. The quantitation limit may be biased low.
mg/l = Milligrams per Liter
ug/l = Micrograms per Liter
Bold indicates the analyte was detected
Shading indicates the result exceeded screening criteria
Site-Specific GWSL or BTAG ESL = the site-specific groundwater screening level (GWSL) protective of Kanawha River exposure pathways for ecological and human receptors (CH2M HILL 2012) or the Biological Technical Assistance Group (BTAG) Region 3 ecological screening level (ESL; USEPA 2006).
* Metals were not retained as WWTU area COCs as noted in the *Groundwater to Surface Water and Sediment Risk Evaluation for Metals* report (CH2M HILL 2014).
ft = feet
ID = identification
SVOC = semivolatile organic compounds
VOC = volatile organic compounds

Appendix E
Mann-Kendall Results for Performance Standard 2: Plume Stability (Summary Tables and Key Trend Graphs)

Table E-1. Trend Analysis for Chlorinated Aliphatic Hydrocarbons (CAHs), Individual Monitoring Wells

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Monitoring Well	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum* (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Mann-Kendall Result** (% Confidence)	Trend	Stability
ENBN-I4	9	6	15	60	1.00	12.1	6.81	9.48	59.6% (-)	No Trend	Stable
MW-102	0	15	15	0	1.00	1.00	1.00	1.00	NA	>50% ND	NA
MW-103	0	15	15	0	1.00	1.00	1.00	1.00	NA	>50% ND	NA
TW-26	0	15	15	0	1.00	1.00	1.00	1.00	NA	>50% ND	NA
TW-42	0	15	15	0	1.00	1.00	1.00	1.00	NA	>50% ND	NA
TW-45	14	1	15	93	1.00	321	168	135	100.0% (sig -)	Strong Decreasing	NA
TW-46	9	0	9	100	623	769	701	697	50.0% (.)	No Trend	Stable
TW-52A	14	1	15	93	1.00	11.5	6.94	7.53	98.2% (sig -)	Strong Decreasing	NA
TW-52B	15	0	15	100	10.1	22.4	15.5	12.6	100.0% (sig -)	Strong Decreasing	NA
TW-53	15	0	15	100	246	544	348	332	68.7% (-)	No Trend	Stable
TW-54A	15	0	15	100	2,913	4,885	3,796	3,668	97.7% (sig -)	Strong Decreasing	NA
TW-54B	15	0	15	100	3,627	5,673	4,571	4,444	91.6% (-)	Weak Decreasing	Stable
TW-55	14	0	14	100	9.18	29.0	21.1	21.0	100.0% (sig -)	Strong Decreasing	NA
TW-56	7	7	14	50	1.00	114	53.1	40.7	96.5% (sig -)	Strong Decreasing	NA
TW-57	14	0	14	100	1,764	2,724	2,198	2,154	99.0% (sig -)	Strong Decreasing	NA
TW-58	9	5	14	64	1.00	5.53	2.81	3.05	54.3% (-)	No Trend	Stable
TW-59A	1	13	14	7	1.00	3.61	1.19	1.00	NA	>50% ND	NA
TW-59B	3	12	15	20	1.00	5.79	1.85	1.00	NA	>50% ND	NA
TW-60A	2	12	14	14	1.00	7.05	1.57	1.00	NA	>50% ND	NA
TW-60B	0	14	14	0	1.00	1.00	1.00	1.00	NA	>50% ND	NA
TW-61	10	4	14	71	1.00	8.90	2.87	2.93	98.2% (sig +)	Strong Increasing	NA
TW-62A	1	13	14	7	1.00	15.6	2.04	1.00	NA	>50% ND	NA
TW-62B	14	0	14	100	100	222	157	153	99.8% (sig -)	Strong Decreasing	NA
TW-63A	0	16	16	0	1.00	1.00	1.00	1.00	NA	>50% ND	NA
TW-63B	1	15	16	6	1.00	449	29.0	1.00	NA	>50% ND	NA
TW-64	12	2	14	86	1.00	15.1	11.4	13.1	99.9% (sig +)	Strong Increasing	NA
TW-65A	14	0	14	100	6.66	25.6	13.5	10.3	92.1% (-)	Weak Decreasing	Stable
TW-65B	4	10	14	29	1.00	2.85	1.41	1.00	NA	>50% ND	NA
TW-66B	0	10	10	0	1.00	1.00	1.00	1.00	NA	>50% ND	NA
TW-67B	0	10	10	0	1.00	1.00	1.00	1.00	NA	>50% ND	NA
TW-69A	0	8	8	0	1.00	1.00	1.00	1.00	NA	>50% ND	NA
TW-70B	0	8	8	0	1.00	1.00	1.00	1.00	NA	>50% ND	NA
TW-71A	1	7	8	13	1.00	2.30	1.16	1.00	NA	>50% ND	NA
TW-71B	7	1	8	88	1.00	14.5	5.12	3.84	94.6% (-)	Weak Decreasing	Stable
VW-03A	0	14	14	0	1.00	1.00	1.00	1.00	NA	>50% ND	NA
VW-03B	12	2	14	86	1.00	5.02	2.80	2.90	100.0% (sig -)	Strong Decreasing	NA
VW-15A	0	14	14	0	1.00	1.00	1.00	1.00	NA	>50% ND	NA
VW-15B	14	0	14	100	1.00	35.6	27.5	29.4	52.1% (-)	No Trend	Stable

Table E-1. Trend Analysis for Chlorinated Aliphatic Hydrocarbons (CAHs), Individual Monitoring Wells

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Monitoring Well	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum* (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Mann-Kendall Result** (% Confidence)	Trend	Stability

Notes:

>50% ND = greater than 50 percent of the data are nondetects; trend cannot be determined

mg/L = micrograms per liter

% = percent

IS = insufficient data (less than six sample results)

NA = not applicable

No. = number

* Data reported less than the detection limit were assigned a value of 1 ug/L for the Mann-Kendall test.

** Trend analysis performed using Mann Kendall single-tailed test at 0.05 significance level.

- A strong trend (either increasing or decreasing) will be indicated by a confidence level greater than or equal to 95 percent.
- A weak trend (either increasing or decreasing) will be indicated by a confidence level less than 95 percent but greater than or equal to 90 percent.
- For a COC exhibiting no trend at the 95 percent confidence level, concentrations are deemed stable if the coefficient of variation (COV) is equal to or less than 1.

(-) = negative trend

(+) = positive trend

Table E-2. Trend Analysis for Petroleum Hydrocarbons (PHCs), Individual Monitoring Wells

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Monitoring Well	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum* (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Mann-Kendall Result** (% Confidence)	Trend	Stability
ENBN-I4	15	0	15	100	305	684	473	494	99.7% (sig +)	Strong Increasing	NA
MW-102	15	0	15	100	24.1	3,973	757	559	72.1% (-)	No Trend	Not Stable
MW-103	15	0	15	100	2.61	21.7	9.12	8.13	68.7% (-)	No Trend	Stable
TW-26	12	3	15	80	0.500	7.75	4.06	4.79	99.1% (sig +)	Strong Increasing	NA
TW-42	1	14	15	7	0.500	5.68	0.845	0.500	NA	>50% ND	NA
TW-45	15	0	15	100	13.6	319	143	126	100.0% (sig -)	Strong Decreasing	NA
TW-46	1	8	9	11	0.500	5.68	1.08	0.500	NA	>50% ND	NA
TW-52A	2	13	15	13	0.500	1.57	0.581	0.500	NA	>50% ND	NA
TW-52B	15	0	15	100	2.27	7.33	4.47	4.50	100.0% (sig -)	Strong Decreasing	NA
TW-53	15	0	15	100	20.3	43.4	29.5	29.9	50.0% (+)	No Trend	Stable
TW-54A	1	14	15	7	0.500	5.77	0.851	0.500	NA	>50% ND	NA
TW-54B	1	14	15	7	0.500	18.4	1.69	0.500	NA	>50% ND	NA
TW-55	14	0	14	100	85.9	236	174	180	88.3% (-)	No Trend	Stable
TW-56	0	14	14	0	0.500	0.500	0.500	0.500	NA	>50% ND	NA
TW-57	1	13	14	7	0.500	5.24	0.839	0.500	NA	>50% ND	NA
TW-58	4	10	14	29	0.500	7.05	1.59	0.500	NA	>50% ND	NA
TW-59A	1	13	14	7	0.500	17.5	1.71	0.500	NA	>50% ND	NA
TW-59B	0	15	15	0	0.500	0.500	0.500	0.500	NA	>50% ND	NA
TW-60A	9	5	14	64	0.500	10.6	4.09	2.03	96.9% (sig -)	Strong Decreasing	NA
TW-60B	1	13	14	7	0.500	0.822	0.523	0.500	NA	>50% ND	NA
TW-61	1	13	14	7	0.500	18.5	1.78	0.500	NA	>50% ND	NA
TW-62A	12	2	14	86	0.500	35.0	10.4	5.94	50.0% (-)	No Trend	Not Stable
TW-62B	14	0	14	100	12.7	33.4	22.4	21.5	100.0% (sig -)	Strong Decreasing	NA
TW-63A	16	0	16	100	7,477	42,797	26,611	29,184	87.0% (-)	No Trend	Stable
TW-63B	16	0	16	100	77.7	21,907	12,916	15,639	100.0% (sig -)	Strong Decreasing	NA
TW-64	1	13	14	7	0.500	35.8	3.02	0.500	NA	>50% ND	NA
TW-65A	0	14	14	0	0.500	0.500	0.500	0.500	NA	>50% ND	NA
TW-65B	1	13	14	7	0.500	4.00	0.750	0.500	NA	>50% ND	NA
TW-66B	10	0	10	100	45,950	141,050	113,207	123,950	99.5% (sig -)	Strong Decreasing	NA
TW-67B	10	0	10	100	7,370	79,350	43,455	42,205	90.7% (-)	Weak Decreasing	Stable
TW-69A	8	0	8	100	5,950	10,730	8,295	7,655	72.6% (-)	No Trend	Stable
TW-70B	8	0	8	100	1,226	4,380	2,857	2,835	64.0% (+)	No Trend	Stable
TW-71A	2	6	8	25	0.500	3.67	1.07	0.500	NA	>50% ND	NA
TW-71B	8	0	8	100	24.7	46.9	38.3	38.8	99.7% (sig -)	Strong Decreasing	NA
VW-03A	2	12	14	14	0.500	7.80	1.07	0.500	NA	>50% ND	NA
VW-03B	1	13	14	7	0.500	1.71	0.587	0.500	NA	>50% ND	NA
VW-15A	2	12	14	14	0.500	46.2	3.88	0.500	NA	>50% ND	NA
VW-15B	1	13	14	7	0.500	17.7	1.73	0.500	NA	>50% ND	NA

Table E-2. Trend Analysis for Petroleum Hydrocarbons (PHCs), Individual Monitoring Wells

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Monitoring Well	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum* (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Mann-Kendall Result** (% Confidence)	Trend	Stability

Notes:

>50% ND = greater than 50 percent of the data are nondetects; trend cannot be determined

mg/L = micrograms per liter

% = percent

IS = insufficient data (less than six sample results)

NA = not applicable

No. = number

* Data reported less than the detection limit were assigned a value of 0.5 µg/L for the Mann-Kendall test.

** Trend analysis performed using Mann Kendall single-tailed test at 0.05 significance level.

- A strong trend (either increasing or decreasing) will be indicated by a confidence level greater than or equal to 95 percent.
- A weak trend (either increasing or decreasing) will be indicated by a confidence level less than 95 percent but greater than or equal to 90 percent.
- For a COC exhibiting no trend at the 95 percent confidence level, concentrations are deemed stable if the coefficient of variation (COV) is equal to or less than 1.

(-) = negative trend

(+) = positive trend

Table E-3. Trend Analysis for Carbon Tetrachloride, Individual Monitoring Wells

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Monitoring Well	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum* (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Mann-Kendall Result** (% Confidence)	Trend	Stability
ENBN-I4	0	15	15	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
MW-102	0	15	15	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
MW-103	0	15	15	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-26	0	15	15	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-42	15	0	15	100	820	1,450	1,162	1,140	59.6% (+)	No Trend	Stable
TW-45	0	15	15	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-46	0	9	9	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-52A	0	15	15	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-52B	0	15	15	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-53	0	15	15	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-54A	15	0	15	100	145	494	369	414	97.1% (sig -)	Strong Decreasing	NA
TW-54B	0	15	15	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-55	14	0	14	100	41.5	104	69.9	66.2	80.6% (-)	No Trend	Stable
TW-56	14	0	14	100	226	410	349	351	77.5% (+)	No Trend	Stable
TW-57	14	0	14	100	262	850	562	575	100.0% (sig -)	Strong Decreasing	NA
TW-58	0	14	14	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-59A	14	0	14	100	53.4	477	253	223	100.0% (sig -)	Strong Decreasing	NA
TW-59B	15	0	15	100	982	2,360	1,683	1,700	53.9% (-)	No Trend	Stable
TW-60A	0	14	14	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-60B	0	14	14	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-61	1	13	14	7	0.100	1.16	0.176	0.100	NA	>50% ND	NA
TW-62A	0	14	14	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-62B	0	14	14	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-63A	0	16	16	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-63B	0	16	16	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-64	0	14	14	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-65A	0	14	14	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-65B	0	14	14	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-66B	0	10	10	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-67B	0	10	10	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-69A	0	7	7	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-70B	8	0	8	100	61.1	428	223	198	54.8% (+)	No Trend	Stable
TW-71A	0	8	8	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
TW-71B	0	8	8	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
VW-03A	0	14	14	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
VW-03B	0	14	14	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
VW-15A	0	14	14	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA
VW-15B	0	14	14	0	0.100	0.100	0.100	0.100	NA	>50% ND	NA

Table E-3. Trend Analysis for Carbon Tetrachloride, Individual Monitoring Wells

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Monitoring Well	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum* (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Mann-Kendall Result** (% Confidence)	Trend	Stability

Notes:

>50% ND = greater than 50 percent of the data are nondetects; trend cannot be determined.

mg/L = micrograms per liter

% = percent

IS = insufficient data (less than six sample results)

NA = not applicable

No. = number

* Data reported less than the detection limit were assigned a value of 0.1 µg/L for the Mann-Kendall test.

** Trend analysis performed using Mann Kendall single-tailed test at 0.05 significance level.

- A strong trend (either increasing or decreasing) will be indicated by a confidence level greater than or equal to 95 percent.
- A weak trend (either increasing or decreasing) will be indicated by a confidence level less than 95 percent but greater than or equal to 90 percent.
- For a COC exhibiting no trend at the 95 percent confidence level, concentrations are deemed stable if the coefficient of variation (COV) is equal to or less than 1.

(-) = negative trend

(+) = positive trend

Table E-4. Trend Analysis for Chloroform, Individual Monitoring Wells

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Monitoring Well	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum* (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Mann-Kendall Result** (% Confidence)	Trend	Stability
ENBN-I4	11	4	15	73	0.050	55.2	24.9	32.7	93.0% (-)	Weak Decreasing	Stable
MW-102	0	15	15	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
MW-103	0	15	15	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-26	0	15	15	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-42	15	0	15	100	6,130	12,200	9,223	9,320	97.4% (sig -)	Strong Decreasing	NA
TW-45	15	0	15	100	38.2	171	94.1	74.7	100.0% (sig -)	Strong Decreasing	NA
TW-46	9	0	9	100	1,480	2,930	1,847	1,820	98.8% (sig -)	Strong Decreasing	NA
TW-52A	0	15	15	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-52B	0	15	15	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-53	14	1	15	93	0.050	33.3	15.5	11.5	95.8% (sig +)	Strong Increasing	NA
TW-54A	15	0	15	100	196	760	369	357	99.9% (sig -)	Strong Decreasing	NA
TW-54B	15	0	15	100	328	806	641	696	98.6% (sig -)	Strong Decreasing	NA
TW-55	14	0	14	100	20.4	32.9	26.0	26.8	68.6% (-)	No Trend	Stable
TW-56	14	0	14	100	6,730	11,300	8,921	8,720	58.5% (-)	No Trend	Stable
TW-57	14	0	14	100	11,400	21,300	14,136	13,350	64.6% (-)	No Trend	Stable
TW-58	1	13	14	7	0.050	5.63	0.449	0.050	NA	>50% ND	NA
TW-59A	14	0	14	100	9.60	87.3	24.1	20.0	96.0% (sig -)	Strong Decreasing	NA
TW-59B	15	0	15	100	16.0	821	206	166	99.9% (sig -)	Strong Decreasing	NA
TW-60A	0	14	14	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-60B	0	14	14	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-61	14	0	14	100	14.6	381	157	142	100.0% (sig -)	Strong Decreasing	NA
TW-62A	0	14	14	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-62B	2	12	14	14	0.050	2.94	0.334	0.050	NA	>50% ND	NA
TW-63A	0	16	16	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-63B	0	16	16	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-64	0	14	14	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-65A	0	14	14	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-65B	0	14	14	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-66B	0	10	10	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-67B	0	10	10	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-69A	7	0	7	100	476	989	786	769	99.5% (sig -)	Strong Decreasing	NA
TW-70B	8	0	8	100	3,310	4,460	3,716	3,680	59.4% (-)	No Trend	Stable
TW-71A	0	8	8	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
TW-71B	8	0	8	100	2.44	654	296	307	100.0% (sig -)	Strong Decreasing	NA
VW-03A	0	14	14	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
VW-03B	14	0	14	100	3.66	51.5	19.8	18.2	100.0% (sig -)	Strong Decreasing	NA
VW-15A	0	14	14	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA
VW-15B	0	14	14	0	0.050	0.050	0.050	0.050	NA	>50% ND	NA

Table E-4. Trend Analysis for Chloroform, Individual Monitoring Wells

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Monitoring Well	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum* (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Mann-Kendall Result** (% Confidence)	Trend	Stability

Notes:

>50% ND = greater than 50 percent of the data are nondetects; trend cannot be determined.

mg/L = micrograms per liter

% = percent

IS = insufficient data (less than six sample results)

NA = not applicable

No. = number

* Data reported less than the detection limit were assigned a value of 0.1 µg/L for the Mann-Kendall test.

** Trend analysis performed using Mann Kendall single-tailed test at 0.05 significance level.

- A strong trend (either increasing or decreasing) will be indicated by a confidence level greater than or equal to 95 percent.
- A weak trend (either increasing or decreasing) will be indicated by a confidence level less than 95 percent but greater than or equal to 90 percent.
- For a COC exhibiting no trend at the 95 percent confidence level, concentrations are deemed stable if the coefficient of variation (COV) is equal to or less than 1.

(-) = negative trend

(+) = positive trend

Table E-5. Trend Analysis for Non-Targeted COCs, Individual Monitoring Wells
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia

Monitoring Well	Non-Targeted COC	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum (µg/L)	Maximum (µg/L)	Mean (µg/L)	Median (µg/L)	Mann-Kendall Result* (% Confidence)	Trend	Stability
ENBN-I4	Trichlorofluoromethane	13	0	13	100	4,950	9,670	6,880	6,740	84.7% (-)	No Trend	Stable
MW-102	Phenol	5	2	7	71	0.255	125	30.0	24.3	61.4% (+)	No Trend	Not Stable
TW-45	Dichlorodifluoromethane	13	0	13	100	813	1,830	1,345	1,320	99.9% (sig -)	Strong Decreasing	NA
TW-52A	Bis (2-chloroethyl) ether	14	0	14	100	9.26	888	204	38.4	100.0% (sig -)	Strong Decreasing	NA
TW-52A	Bis (2-chloroisopropyl) ether	15	0	15	100	8.48	57.1	29.6	27.7	99.2% (sig -)	Strong Decreasing	NA
TW-52B	Bis (2-chloroethyl) ether	14	0	14	100	15.5	27,000	5,761	43.5	100.0% (sig -)	Strong Decreasing	NA
TW-52B	Bis (2-chloroisopropyl) ether	14	0	14	100	50.1	939	441	466	99.3% (sig -)	Strong Decreasing	NA
TW-54B	Trichlorofluoromethane	12	0	12	100	2,140	10,200	6,744	7,685	95.7% (sig -)	Strong Decreasing	NA
TW-56	Dichlorodifluoromethane	13	0	13	100	690	1,120	964	925	50.0% (.)	No Trend	Stable
TW-56	Trichlorofluoromethane	13	0	13	100	25,600	44,400	31,292	28,100	99.7% (sig -)	Strong Decreasing	NA
TW-57	Dichlorodifluoromethane	12	0	12	100	1,560	3,140	2,313	2,305	65.6% (+)	No Trend	Stable
TW-57	Trichlorofluoromethane	12	0	12	100	3,400	7,720	4,588	4,400	86.0% (+)	No Trend	Stable
TW-60A	1,4-Dioxane	9	1	10	90	15.8	183	78.7	52.7	96.4% (sig -)	Strong Decreasing	Stable
TW-60B	1,4-Dioxane	9	0	9	100	3.87	50.0	18.92	11.90	99.5% (sig -)	Strong Decreasing	Stable
TW-63A	Phenol	14	0	14	100	88.6	339	195	178	83.5% (-)	No Trend	Stable
TW-63B	Phenol	11	4	15	73	0.250	120	36.4	26.0	98.2% (sig -)	Strong Decreasing	NA
TW-65B	1,4-Dioxane	7	1	8	88	10.30	100.0	26.4	16.4	86.2% (-)	No Trend	Not Stable

Notes:

>50% ND = greater than 50 percent of the data are nondetects; trend cannot be determined.

µg/L = micrograms per liter

% = percent

COC = constitutent of concern

IS = insufficient data (less than six sample results)

NA = not applicable

No. = number

* Trend analysis performed using Mann Kendall single-tailed test at 0.05 significance level.

- A strong trend (either increasing or decreasing) will be indicated by a confidence level greater than or equal to 95 percent.
- A weak trend (either increasing or decreasing) will be indicated by a confidence level less than 95 percent but greater than or equal to 90 percent.
- For a COC exhibiting no trend at the 95 percent confidence level, concentrations are deemed stable if the coefficient of variation (COV) is equal to or less than 1.

(-) = negative trend

(+) = positive trend

Table E-6. Trend Analysis for VOCs and SVOCs, WWTU Area

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Compound	Monitoring Well	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum* (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Mann-Kendall Result** (% Confidence)	Trend	Stability
1,4-Dioxane	VW-20A	4	0	4	100	14	80.2	46.45	45.8	NA	IS	NA
	W-10A	8	4	12	67	0.5	383.8	60.86083	36.8	63.1% (+)	No Trend	Not Stable
	W-14	3	1	4	75	0.5	3.06	1.5125	1.245	NA	IS	NA
	W-2A	6	5	11	55	0.5	76.44	19.96182	18.94	82.1% (+)	No Trend	Not Stable
	W-3	7	5	12	58	0.5	429.8	136.0017	103.75	72.7% (+)	No Trend	Not Stable
	W-5	7	5	12	58	0.5	540.34	71.21333	27.85	81.0% (+)	No Trend	Not Stable
	W-5A	11	1	12	92	0.5	1125.58	629.385	615.64	97.8% (sig -)	Strong Decreasing	NA
Benzene	VW-20A	5	0	5	100	7.65	21.4	15.778	18.48	NA	IS	NA
	W-10A	3	9	12	25	0.125	3.28	0.83375	0.125	NA	>50% ND	NA
	W-14	0	3	3	0	0.125	0.125	0.125	0.125	NA	IS	NA
	W-2A	0	11	11	0	0.125	0.125	0.125	0.125	NA	>50% ND	NA
	W-3	0	12	12	0	0.125	0.125	0.125	0.125	NA	>50% ND	NA
	W-5	0	12	12	0	0.125	0.125	0.125	0.125	NA	>50% ND	NA
	W-5A	0	12	12	0	0.125	0.125	0.125	0.125	NA	>50% ND	NA
Tetra-chloroethene	VW-20A	5	0	5	100	19.24	77	46.028	50.6	NA	IS	NA
	W-10A	1	3	4	25	0.25	0.25	0.25	0.25	NA	IS	NA
	W-14	1	2	3	33	0.25	0.25	0.25	0.25	NA	IS	NA
	W-2A	0	3	3	0	0.25	0.25	0.25	0.25	NA	IS	NA
	W-3	1	3	4	25	0.25	0.25	0.25	0.25	NA	IS	NA
	W-5	1	3	4	25	0.25	19.4	5.0375	0.25	NA	IS	NA
	W-5A	1	3	4	25	0.25	5.24	1.4975	0.25	NA	IS	NA
Tri-chloroethene	VW-20A	5	0	5	100	5.2	16.14	11.112	12.56	NA	IS	NA
	W-10A	0	4	4	0	0.25	0.25	0.25	0.25	NA	IS	NA
	W-14	0	4	4	0	0.25	0.25	0.25	0.25	NA	IS	NA
	W-2A	0	3	3	0	0.25	0.25	0.25	0.25	NA	IS	NA
	W-3	0	4	4	0	0.25	0.25	0.25	0.25	NA	IS	NA
	W-5	0	4	4	0	0.25	0.25	0.25	0.25	NA	IS	NA
	W-5A	0	4	4	0	0.25	0.25	0.25	0.25	NA	IS	NA
Trichloro-fluoro-methane	VW-20A	4	0	4	100	53.9	194.6	152.875	181.5	NA	IS	NA
	W-10A	1	3	4	25	0.25	0.25	0.25	0.25	NA	IS	NA
	W-14	2	1	3	67	0.25	3.45	2.026667	2.38	NA	IS	NA
	W-2A	0	3	3	0	0.25	0.25	0.25	0.25	NA	IS	NA
	W-3	0	4	4	0	0.25	0.25	0.25	0.25	NA	IS	NA
	W-5	1	3	4	25	0.25	5.82	1.6425	0.25	NA	IS	NA
	W-5A	1	3	4	25	0.25	1.89	0.66	0.25	NA	IS	NA

Table E-6. Trend Analysis for VOCs and SVOCs, WWTU Area

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Compound	Monitoring Well	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum* (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Mann-Kendall Result** (% Confidence)	Trend	Stability
Vinyl Chloride	VW-20A	4	1	5	80	0.25	55.2	31.47	35.2	NA	IS	NA
	W-10A	0	4	4	0	0.25	0.25	0.25	0.25	NA	IS	NA
	W-14	0	4	4	0	0.25	0.25	0.25	0.25	NA	IS	NA
	W-2A	0	3	3	0	0.25	0.25	0.25	0.25	NA	IS	NA
	W-3	1	3	4	25	0.25	2	0.6875	0.25	NA	IS	NA
	W-5	0	4	4	0	0.25	0.25	0.25	0.25	NA	IS	NA
	W-5A	0	4	4	0	0.25	0.25	0.25	0.25	NA	IS	NA
Bis(2-chloro-ethyl)ether	VW-20A	4	0	4	100	8.06	41.6	24.165	23.5	NA	IS	NA
	W-10A	4	8	12	33	0.25	49.4	11.79	0.25	NA	>50% ND	NA
	W-14	0	3	3	0	0.25	0.25	0.25	0.25	NA	IS	NA
	W-2A	10	1	11	91	0.25	244	146.7318	135.4	67.6% (-)	No Trend	Stable
	W-3	11	1	12	92	0.25	1038	315.3708	285.1	81.0% (+)	No Trend	Stable
	W-5	11	1	12	92	0.25	74.4	37.31583	40.82	98.4% (sig -)	Strong Decreasing	NA
	W-5A	11	1	12	92	0.25	105	53.26417	40.98	92.4% (-)	Weak Decreasing	Stable

Notes:

>50% ND = greater than 50 percent of the data are nondetects; trend cannot be determined.

mg/L = micrograms per liter

% = percent

IS = insufficient data (less than six sample results)

NA = not applicable

No. = number

* Data reported less than the detection limit were assigned a common value less than the smallest measured value for the Mann-Kendall test.

** Trend analysis performed using Mann Kendall single-tailed test at 0.05 significance level.

- A strong trend (either increasing or decreasing) will be indicated by a confidence level greater than or equal to 95 percent.
- A weak trend (either increasing or decreasing) will be indicated by a confidence level less than 95 percent but greater than or equal to 90 percent.
- For a COC exhibiting no trend at the 95 percent confidence level, concentrations are deemed stable if the coefficient of variation (COV) is equal to or less than 1.

(-) = negative trend

(+) = positive trend

Table E-7. Trend Analysis for Metals, WWTU Area
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia

Metal	Monitoring Well	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum* (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Mann-Kendall Result** (% Confidence)	Trend	Stability
Beryllium	VW-20A	0	4	4	0	0.001	0.001	0.001	0.001	NA	IS	NA
	W-10A	0	4	4	0	0.001	0.001	0.001	0.001	NA	IS	NA
	W-14	0	4	4	0	0.001	0.001	0.001	0.001	NA	IS	NA
	W-2A	0	2	2	0	0.001	0.001	0.001	0.001	NA	IS	NA
	W-3	0	4	4	0	0.001	0.001	0.001	0.001	NA	IS	NA
	W-5	2	2	4	50	0.001	0.052	0.025	0.023	NA	IS	NA
	W-5A	1	3	4	25	0.001	0.007	0.003	0.001	NA	IS	NA
Cadmium	VW-20A	0	4	4	0	0.000	0.000	0.000	0.000	NA	IS	NA
	W-10A	0	4	4	0	0.000	0.000	0.000	0.000	NA	IS	NA
	W-14	3	1	4	75	0.000	0.001	0.001	0.001	NA	IS	NA
	W-2A	0	2	2	0	0.000	0.000	0.000	0.000	NA	IS	NA
	W-3	4	0	4	100	0.002	0.005	0.004	0.004	NA	IS	NA
	W-5	4	0	4	100	0.001	0.003	0.002	0.002	NA	IS	NA
	W-5A	1	3	4	25	0.000	0.002	0.001	0.001	NA	IS	NA
Cobalt	VW-20A	2	2	4	50	0.001	0.034	0.016	0.014	NA	IS	NA
	W-10A	2	2	4	50	0.001	0.005	0.002	0.002	NA	IS	NA
	W-14	2	1	3	67	0.001	0.008	0.004	0.004	NA	IS	NA
	W-2A	1	1	2	50	0.001	0.028	0.015	0.015	NA	IS	NA
	W-3	2	2	4	50	0.001	0.033	0.013	0.008	NA	IS	NA
	W-5	4	0	4	100	0.028	0.083	0.064	0.072	NA	IS	NA
	W-5A	2	2	4	50	0.001	0.010	0.004	0.003	NA	IS	NA
Lead	VW-20A	0	4	4	0	0.000	0.000	0.000	0.000	NA	IS	NA
	W-10A	1	3	4	25	0.000	0.002	0.001	0.000	NA	IS	NA
	W-14	0	3	3	0	0.000	0.000	0.000	0.000	NA	IS	NA
	W-2A	0	2	2	0	0.000	0.000	0.000	0.000	NA	IS	NA
	W-3	0	4	4	0	0.000	0.000	0.000	0.000	NA	IS	NA
	W-5	0	4	4	0	0.000	0.000	0.000	0.000	NA	IS	NA
	W-5A	1	3	4	25	0.000	0.002	0.001	0.000	NA	IS	NA
Manganese	VW-20A	4	0	4	100	4.30	6.96	5.97	6.31	NA	IS	NA
	W-10A	4	0	4	100	0.565	2.02	1.41	1.52	NA	IS	NA
	W-14	3	0	3	100	1.90	4.06	3.20	3.64	NA	IS	NA
	W-2A	2	0	2	100	12.6	14.8	13.7	13.7	NA	IS	NA
	W-3	4	0	4	100	9.85	23.0	18.6	20.8	NA	IS	NA
	W-5	4	0	4	100	20.9	39.6	34.3	38.3	NA	IS	NA
	W-5A	4	0	4	100	36.4	63.6	53.0	56.0	NA	IS	NA

Table E-7. Trend Analysis for Metals, WWTU Area

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia

Metal	Monitoring Well	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum* (mg/L)	Maximum (mg/L)	Mean (mg/L)	Median (mg/L)	Mann-Kendall Result** (% Confidence)	Trend	Stability

Notes:

>50% ND = greater than 50 percent of the data are nondetects; trend cannot be determined

mg/L = milligrams per liter

% = percent

IS = insufficient data (less than six sample results)

NA = not applicable

No. = number

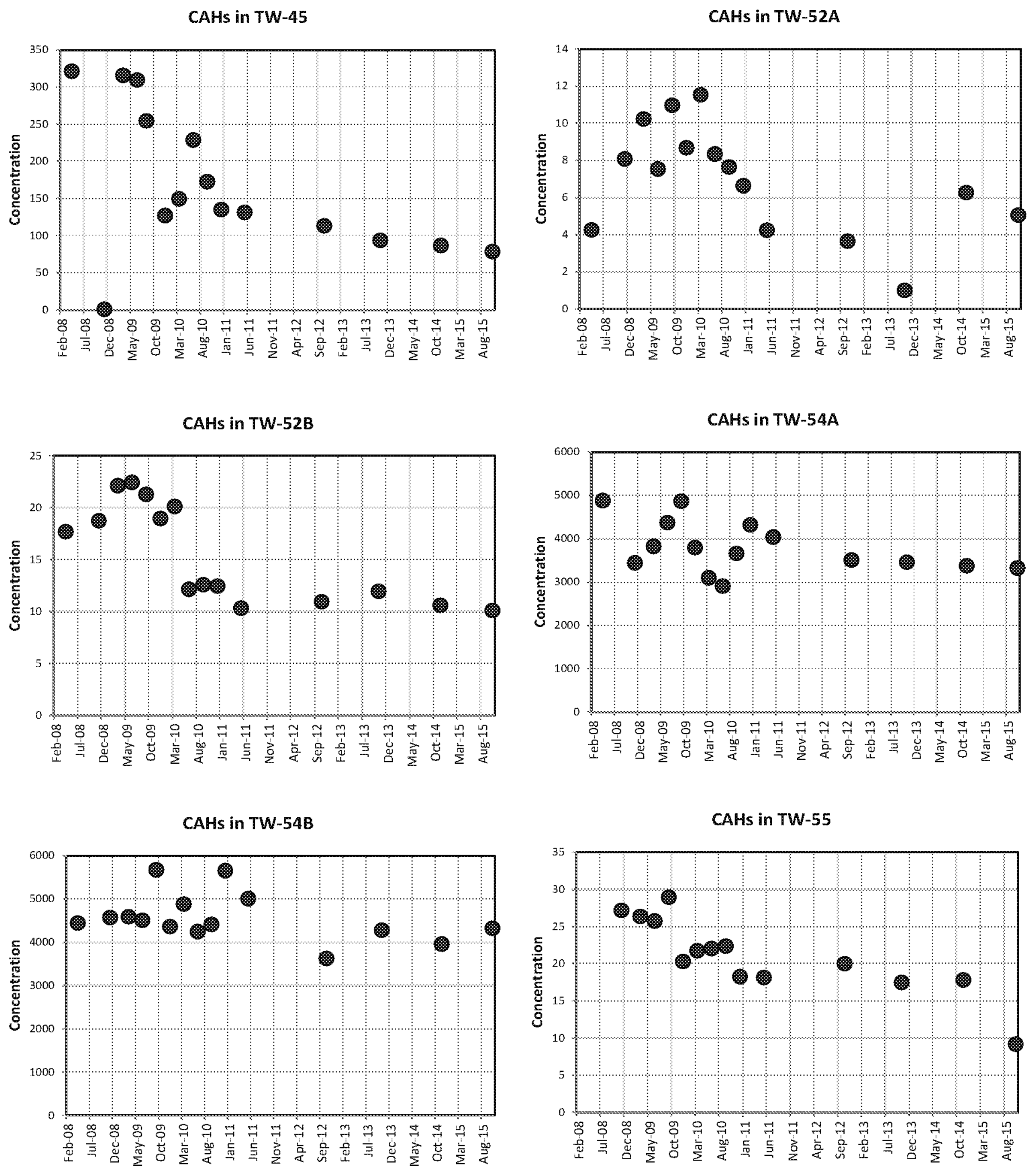
* Data reported less than the detection limit were assigned a common value less than the smallest measured value for the Mann-Kendall test

** Trend analysis performed using Mann Kendall single-tailed test at 0.05 significance level

- A strong trend (either increasing or decreasing) will be indicated by a confidence level greater than or equal to 95 percent
- A weak trend (either increasing or decreasing) will be indicated by a confidence level less than 95 percent but greater than or equal to 90 percent
- For a COC exhibiting no trend at the 95 percent confidence level, concentrations are deemed stable if the coefficient of variation (COV) is equal to or less than 1

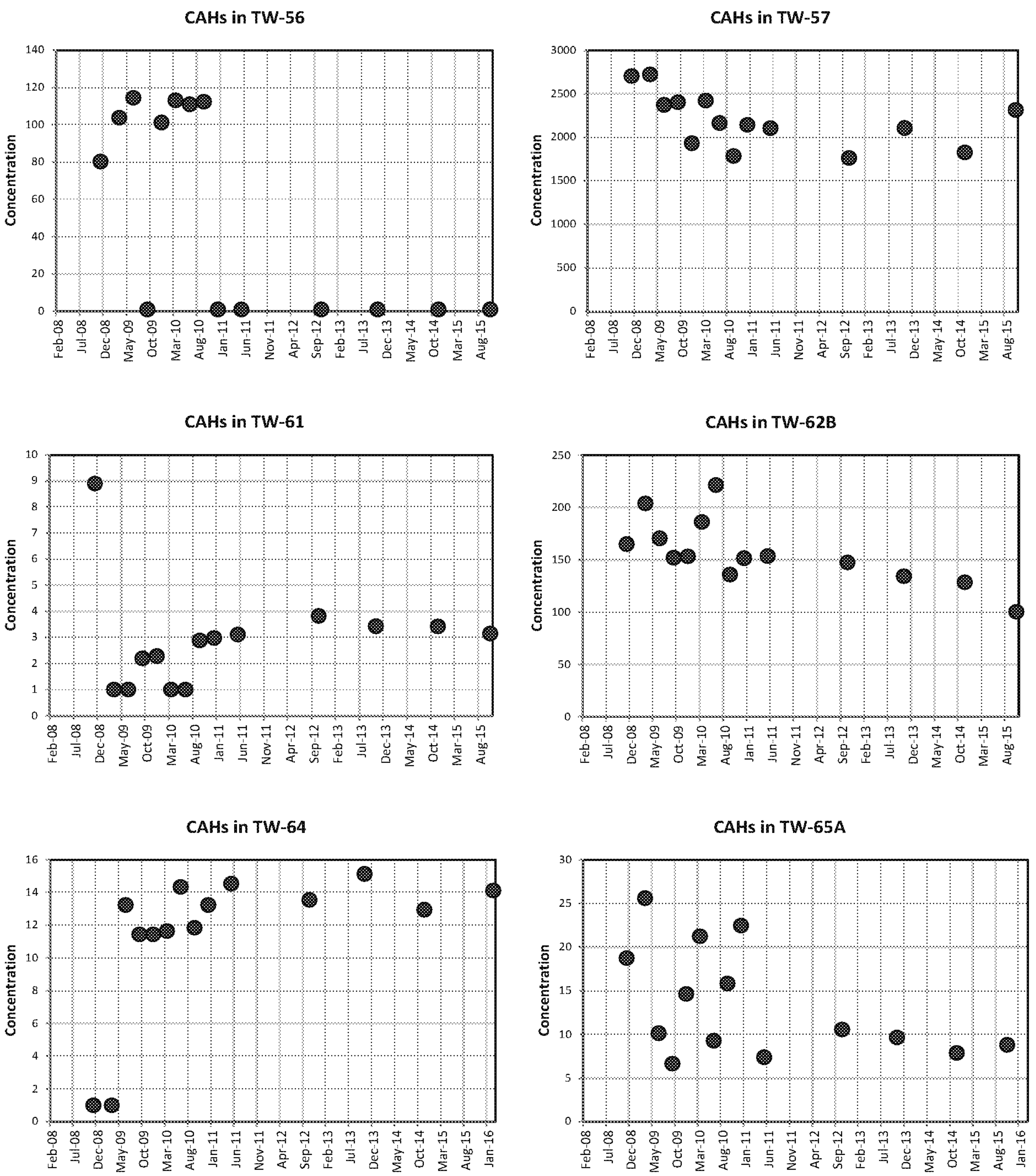
(-) = negative trend

(+) = positive trend



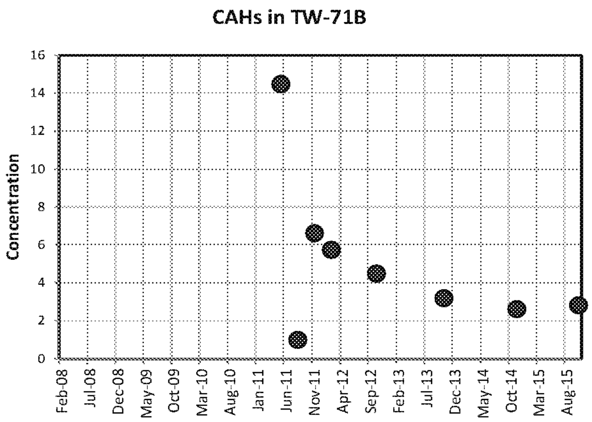
Notes:
1. *All concentrations in micrograms per liter (µg/L)*
2. *CAHs = Chlorinated Aliphatic Hydrocarbons*
3. *Only wells with increasing or decreasing trends are shown*

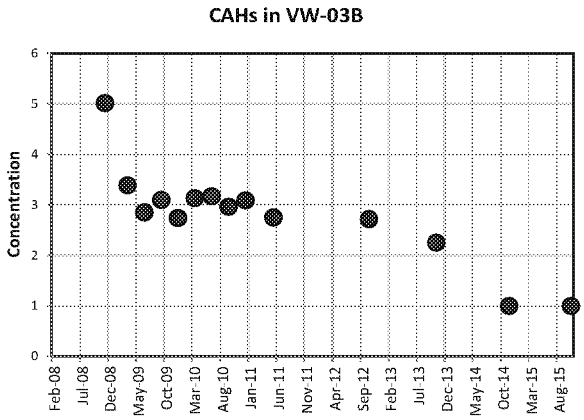
Figure E-1
Temporal Concentrations of CAHs in Monitoring Wells
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia



Notes: 1. *All concentrations in micrograms per liter (µg/L)*
2. *CAHs = Chlorinated Aliphatic Hydrocarbons*
3. *Only wells with increasing or decreasing trends are shown*

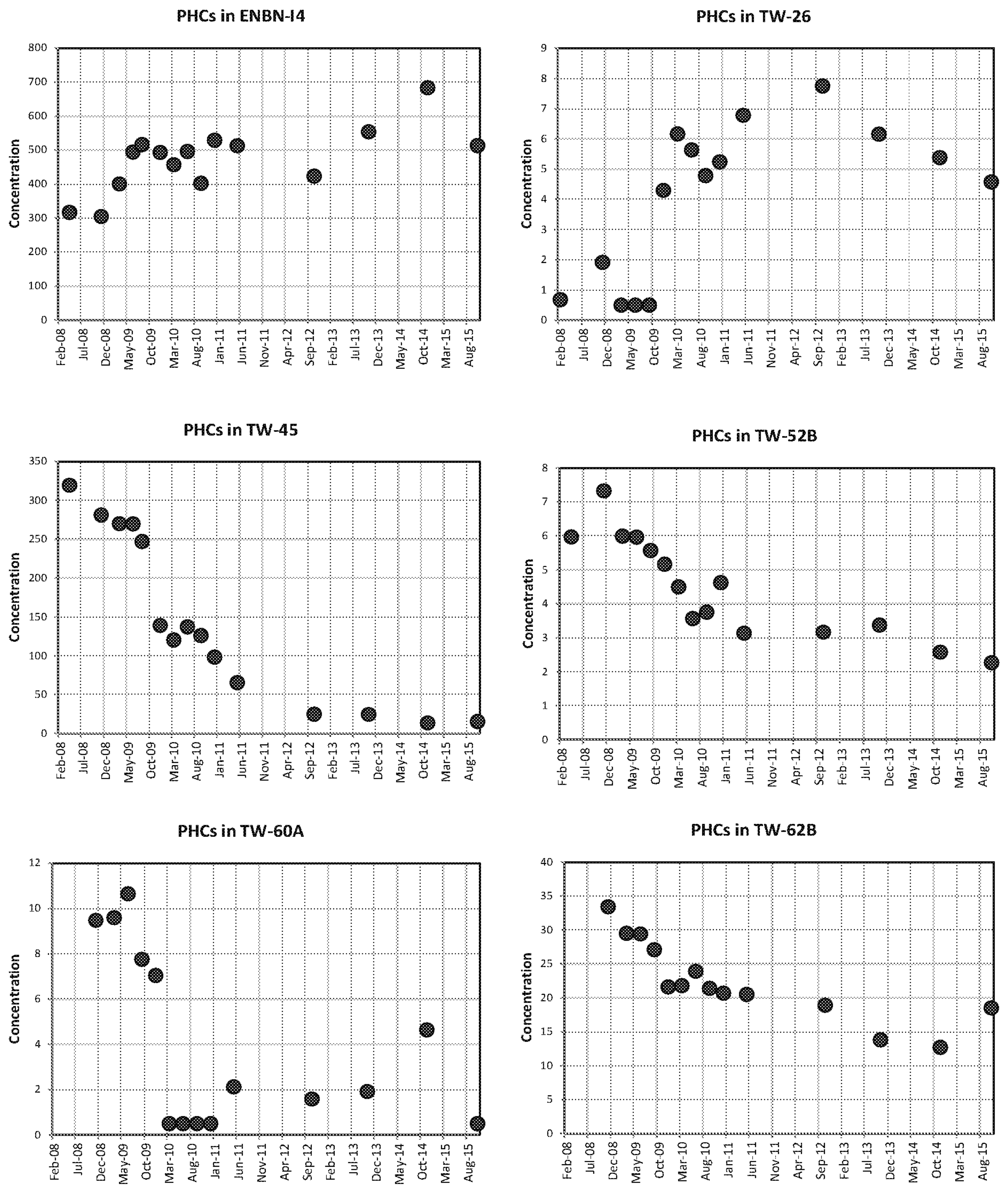
Figure E-1
Temporal Concentrations of CAHs in Monitoring Wells
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia





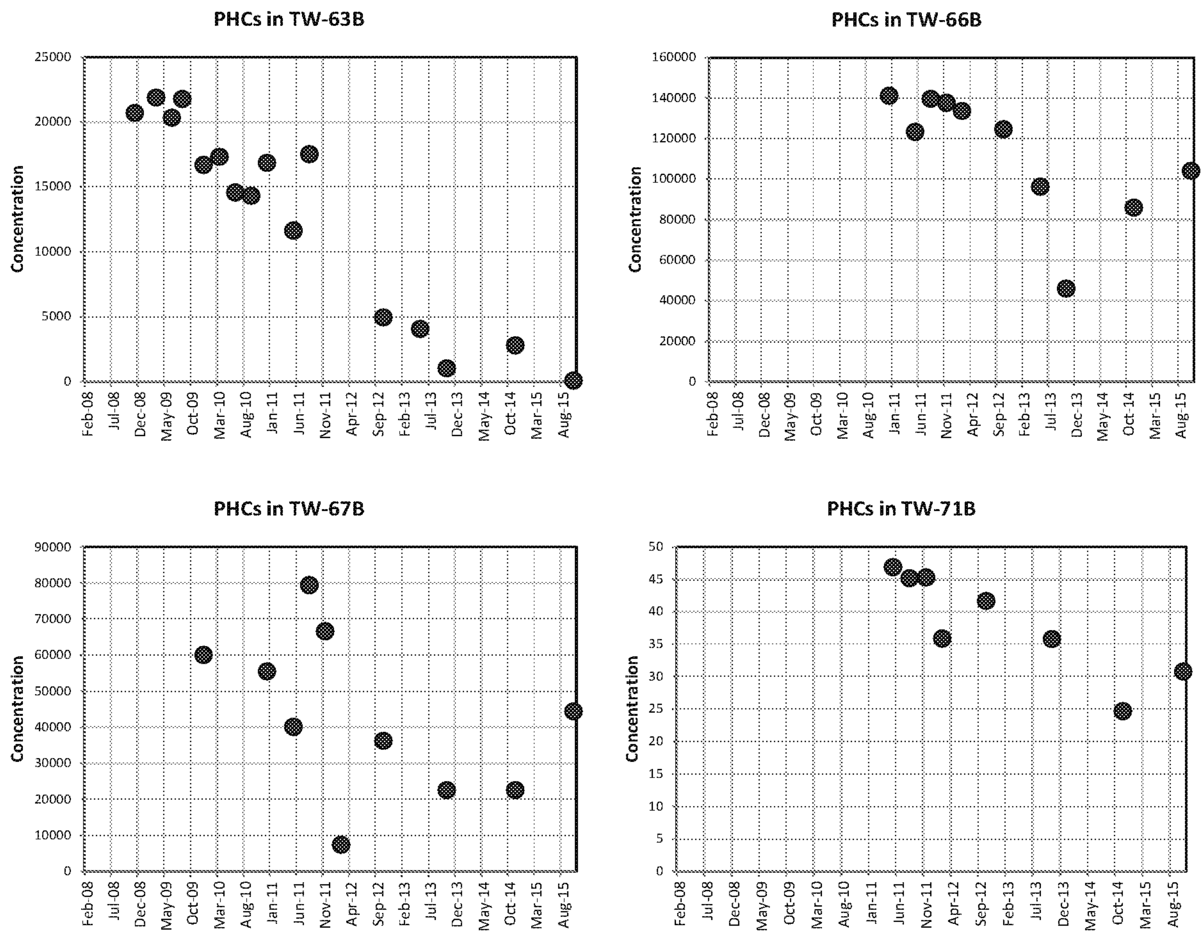
Notes: 1. *All concentrations in micrograms per liter (µg/L)*
2. *CAHs = Chlorinated Aliphatic Hydrocarbons*
3. *Only wells with increasing or decreasing trends are shown*

Figure E-1
Temporal Concentrations of CAHs in Monitoring Wells
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia



Notes: *1. All concentrations in micrograms per liter (µg/L)*
2. PHCs = Petroleum Hydrocarbons
3. Only wells with increasing or decreasing trends are shown

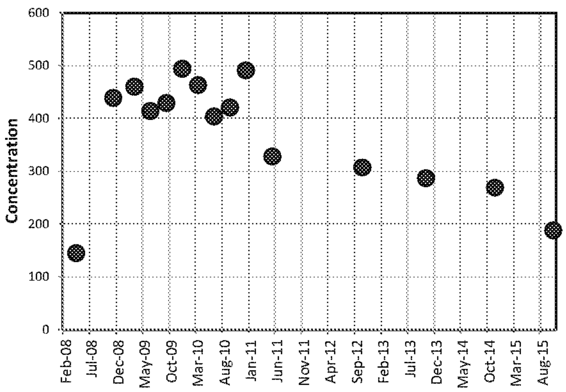
Figure E-2
Temporal Concentrations of PHCs in Monitoring Wells
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia



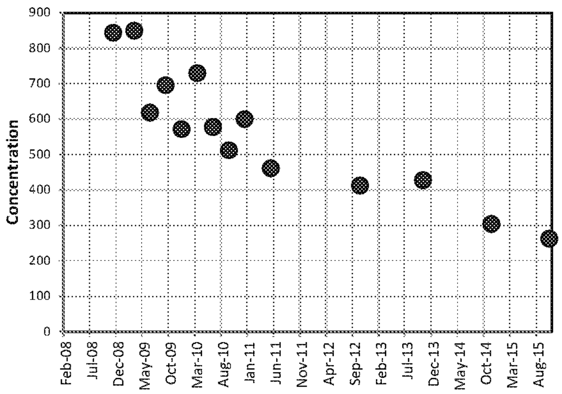
Notes: 1. *All concentrations in micrograms per liter (µg/L)*
2. *PHCs = Petroleum Hydrocarbons*
3. *Only wells with increasing or decreasing trends are shown*

Figure E-2
Temporal Concentrations of PHCs in Monitoring Wells
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia

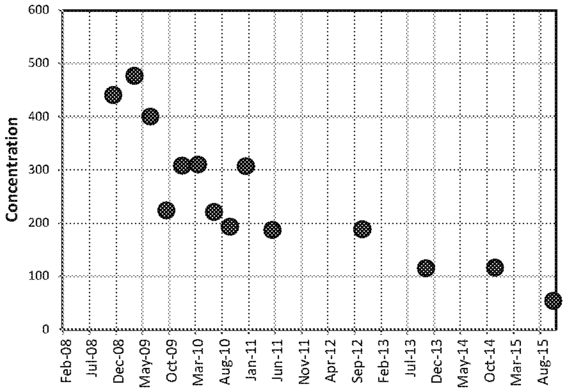
Carbon Tetrachloride in TW-54A



Carbon Tetrachloride in TW-57

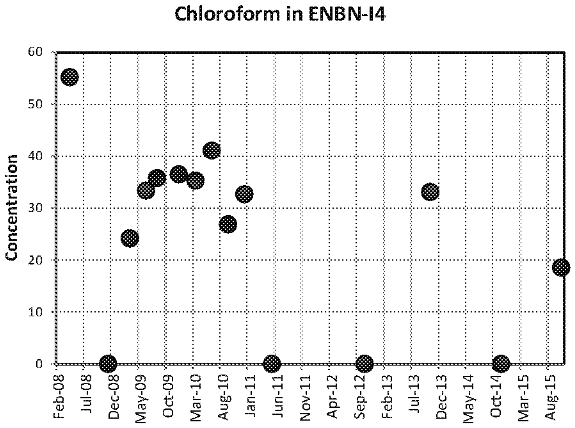


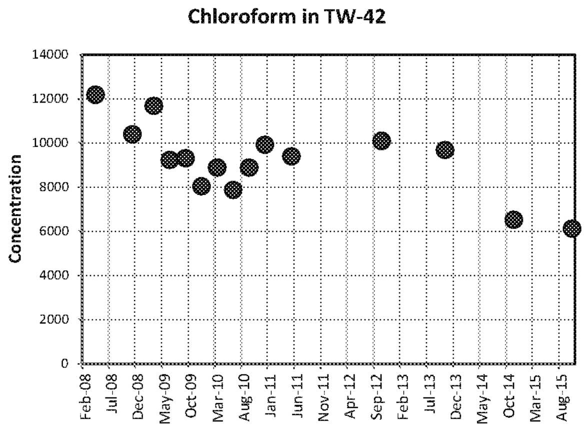
Carbon Tetrachloride in TW-59A

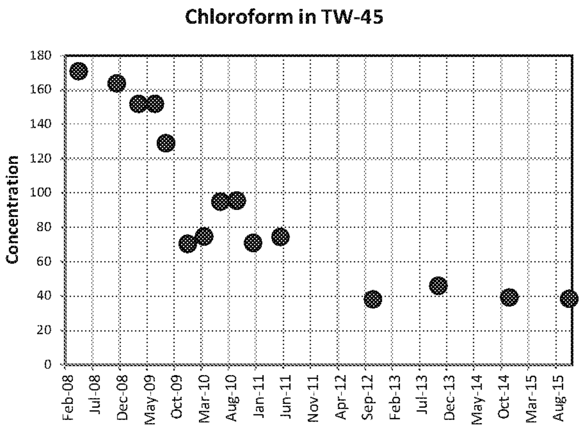


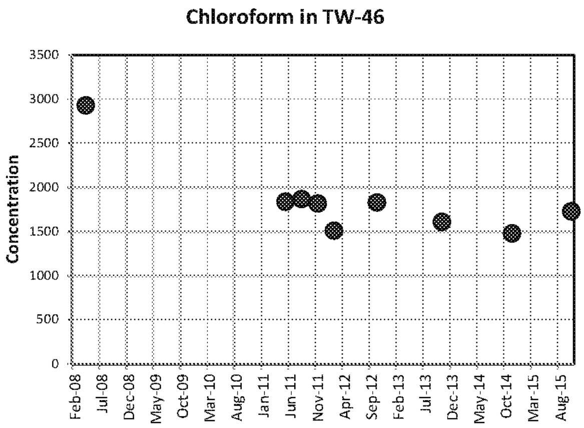
Notes: 1. *All concentrations in micrograms per liter (µg/L)*
2. *Only wells with increasing or decreasing trends are shown*

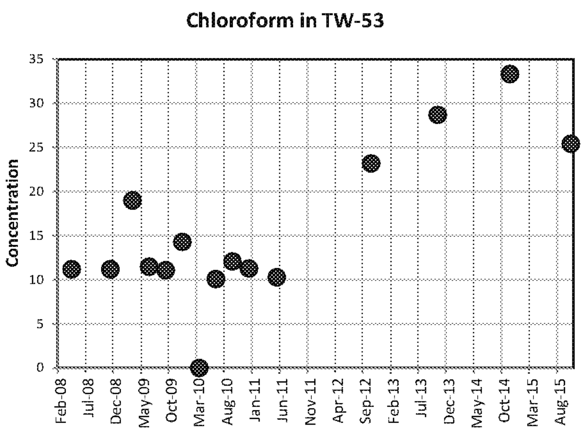
Figure E-3
Temporal Concentrations of Carbon Tetrachloride in Monitoring Wells
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia

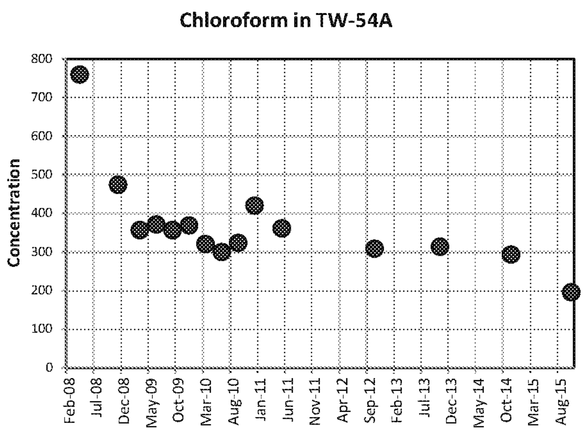






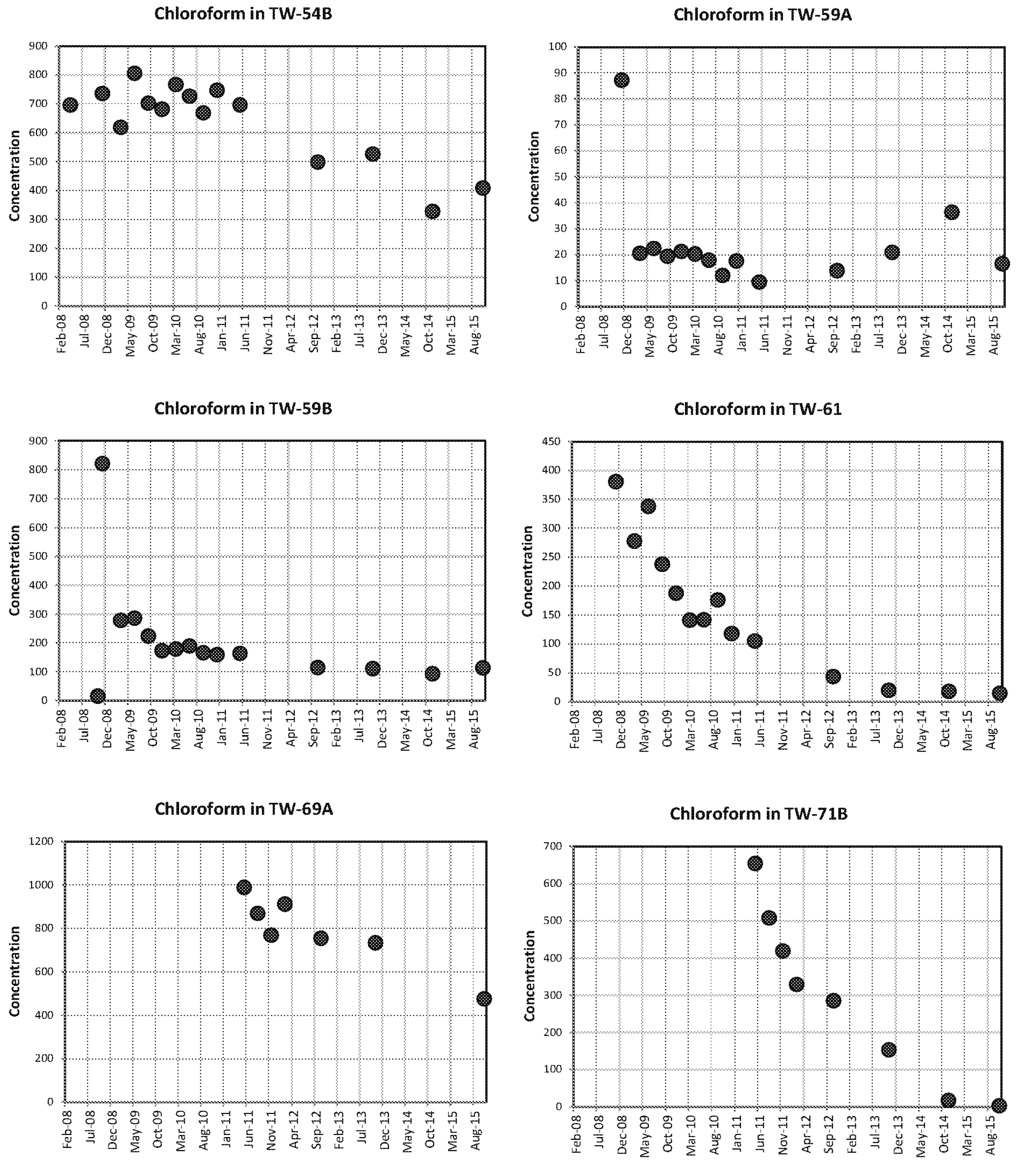






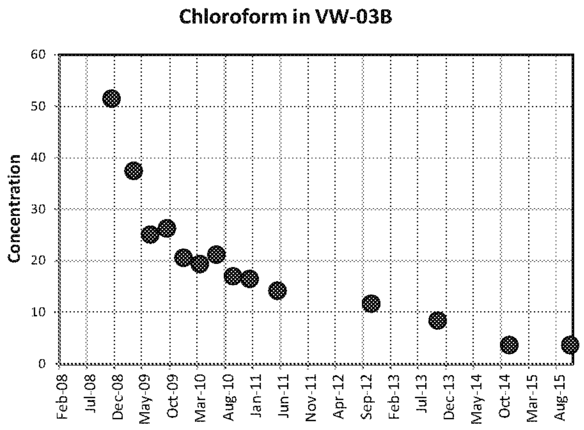
Notes: 1. *All concentrations in micrograms per liter (µg/L)*
2. *Only wells with increasing or decreasing trends are shown*

Figure E-4
Temporal Concentrations of Chloroform in Monitoring Wells
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia



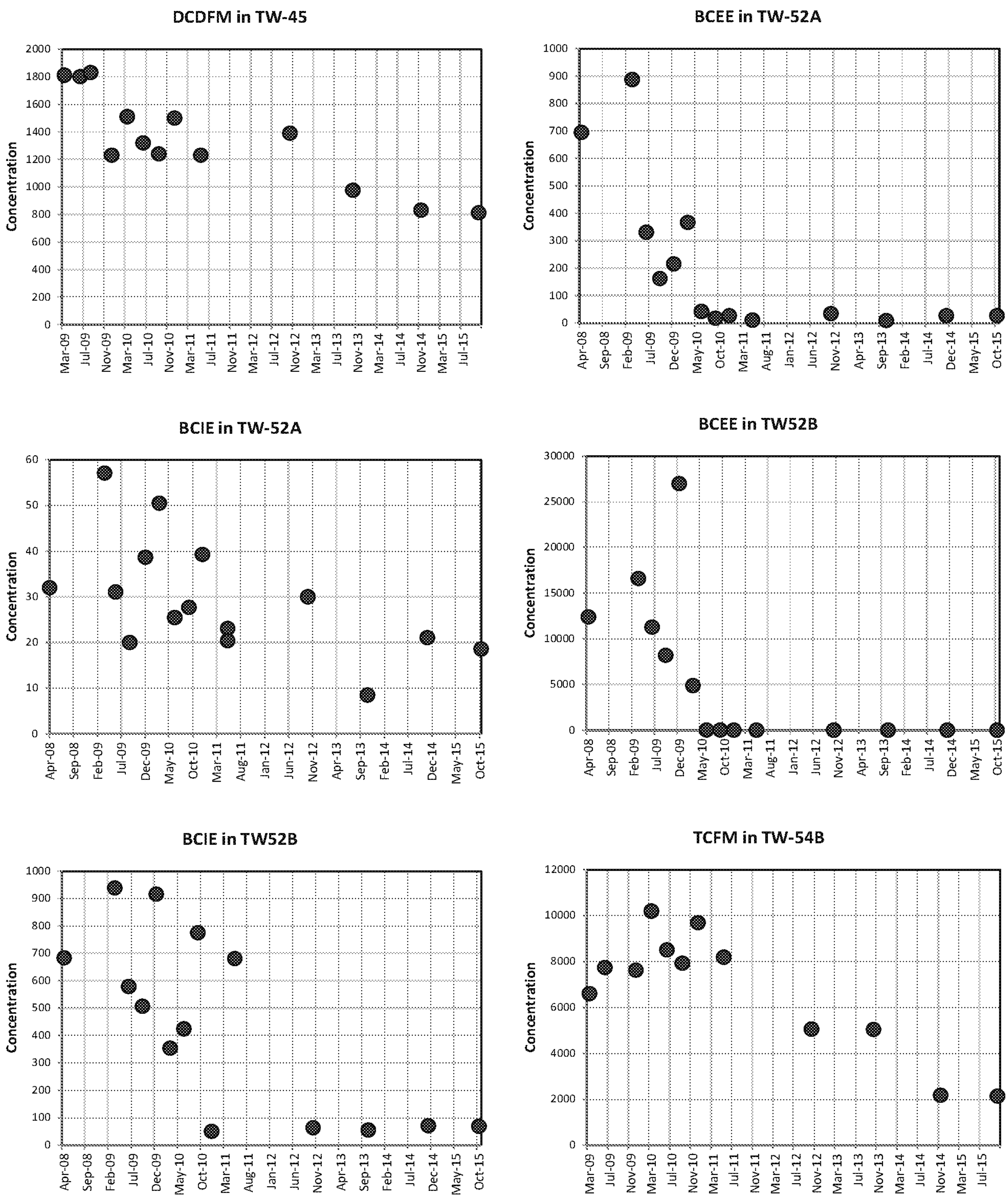
Notes: 1. *All concentrations in micrograms per liter (µg/L)*
2. *Only wells with increasing or decreasing trends are shown*

Figure E-4
Temporal Concentrations of Chloroform in Monitoring Wells
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia



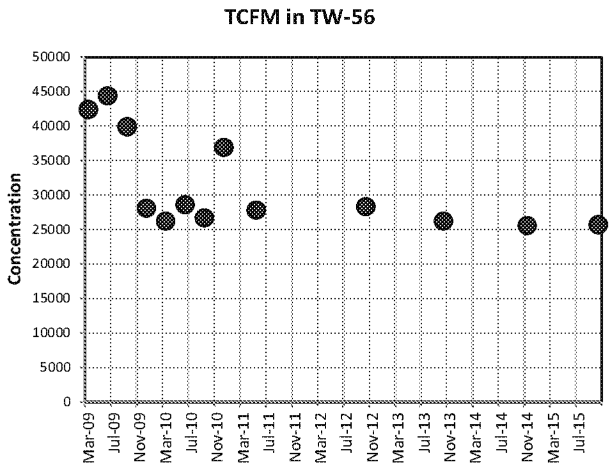
Notes: 1. *All concentrations in micrograms per liter (µg/L)*
2. *Only wells with increasing or decreasing trends are shown*

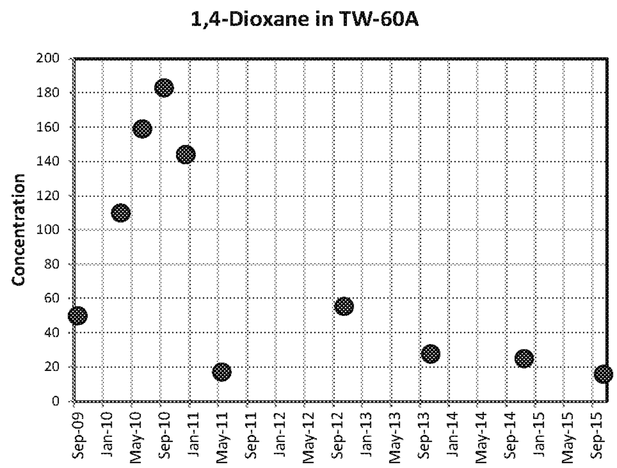
Figure E-4
Temporal Concentrations of Chloroform in Monitoring Wells
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia

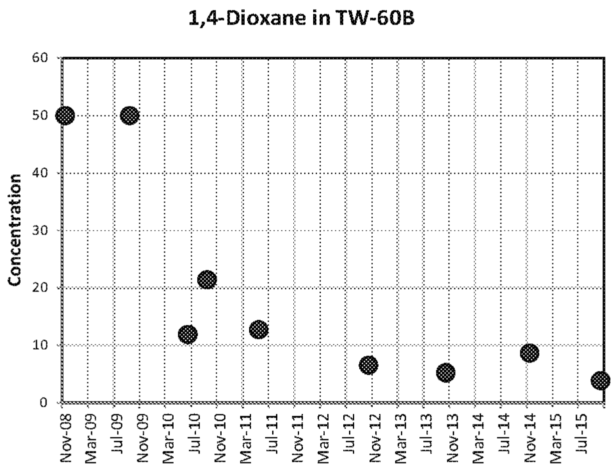


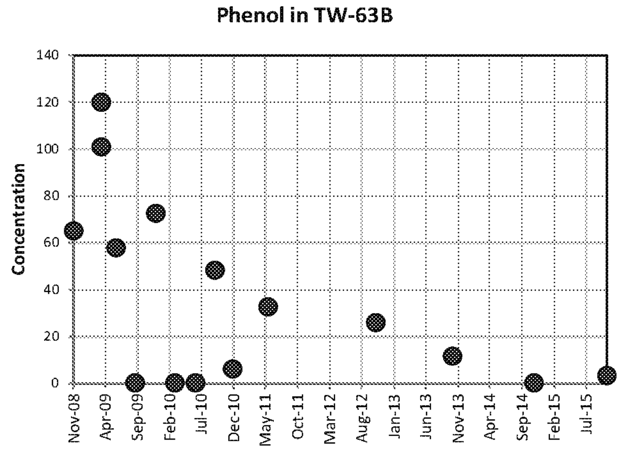
Notes: 1. *All concentrations in micrograms per liter (µg/L)*
2. *BCEE = Bis(2-chloroethyl) ether*
3. *BCIE = Bis(2chloroisopropyl)ether*
4. *TCFM = Trichlorofluoromethane*
5. *DCDFM = Dichlorodifluoromethane*
6. *Only wells with increasing or decreasing trends are shown*

Figure E-5
Temporal Concentrations of Non-Targeted COCs in Monitoring Wells
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia









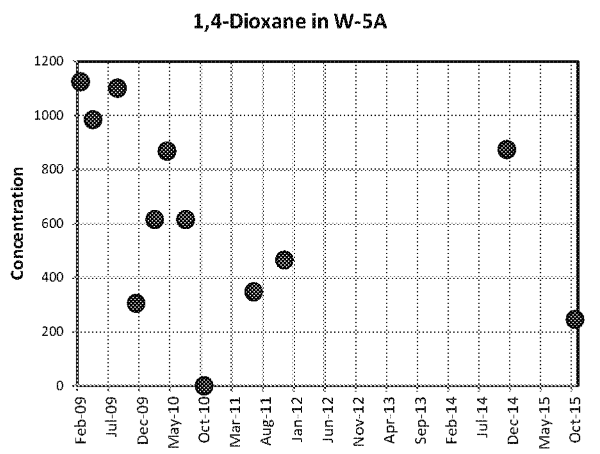
Notes:
1. *All concentrations in micrograms per liter (µg/L)*
2. *BCEE = Bis(2-chloroethyl) ether*
3. *BCIE = Bis(2chloroisopropyl)ether*
4. *TCFM = Trichlorofluoromethane*
5. *DCDFM = Dichlorodifluoromethane*
6. *Only wells with increasing or decreasing trends are shown*

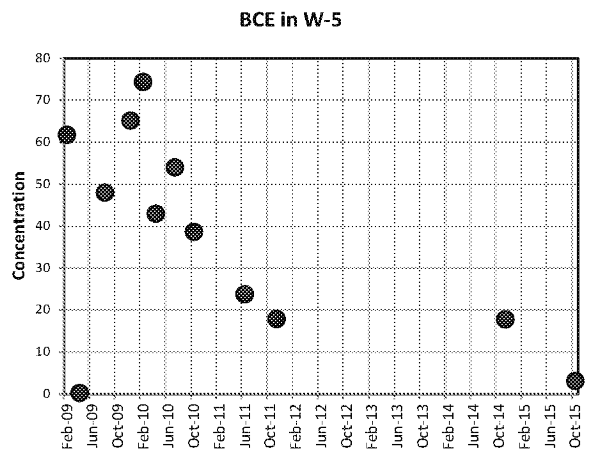
Figure E-5

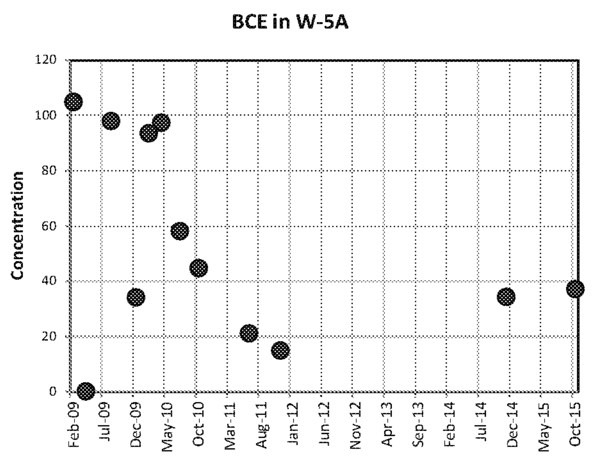
Temporal Concentrations of Non-Targeted COCs in Monitoring Wells

2015 Groundwater Performance Monitoring Report

Union Carbide Corporation Institute Facility, Institute, West Virginia







Notes: 1. *All concentrations in micrograms per liter (µg/L)*
2. *Only wells with increasing or decreasing trends are shown*
3. *BCE = Bis(2-chloroethyl)ether*

Figure E-6
Temporal Concentrations of VOCs and SVOCs in WWTU Monitoring Wells
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility, Institute, West Virginia

Appendix F
Mann-Kendall Results for Performance Standard 3: Reduction in Constituent Mass
(Summary Tables and Trend Graphs)

Table F-1. Trend Analysis for Key COC Groups - Thiessen Polygon Monitoring Well Network Mass Trends

2015 Groundwater Performance Monitoring Report

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COC Group	No. of Detected Samples	No. of Nondetected Samples	Total Samples	Detection Frequency (%)	Minimum (kg)	Maximum (kg)	Mean (kg)	Median (kg)	Mann-Kendall Result* (% Confidence)	Trend	Stability
Chlorinated Aliphatic Hydrocarbons (CAHs)	18	0	18	100	491	688	571	553	99.9% (sig -)	Strong Decreasing	NA
Petroleum Hydrocarbons (PHCs)	10	0	10	100	2,005	5,807	4,265	4,416	99.5% (sig -)	Strong Decreasing	NA
Carbon Tetrachloride	18	0	18	100	225	376	302	293	99.6% (sig -)	Strong Decreasing	NA
Chloroform	18	0	18	100	2,386	3,367	2,699	2,578	91.4% (-)	Weak Decreasing	Stable

Notes:

% = percent

COC = constituent of concern

kg = kilogram

NA = not applicable

No. = number

* Trend analysis performed using Mann Kendall single-tailed test at 0.05 significance level.

- A strong trend (either increasing or decreasing) will be indicated by a confidence level greater than or equal to 95 percent
- A weak trend (either increasing or decreasing) will be indicated by a confidence level less than 95 percent but greater than or equal to 90 percent.
- For a COC exhibiting no trend at the 95 percent confidence level, concentrations are deemed stable if the coefficient of variation (COV) is equal to or less than 1.

(-) = negative trend

(+) = positive trend

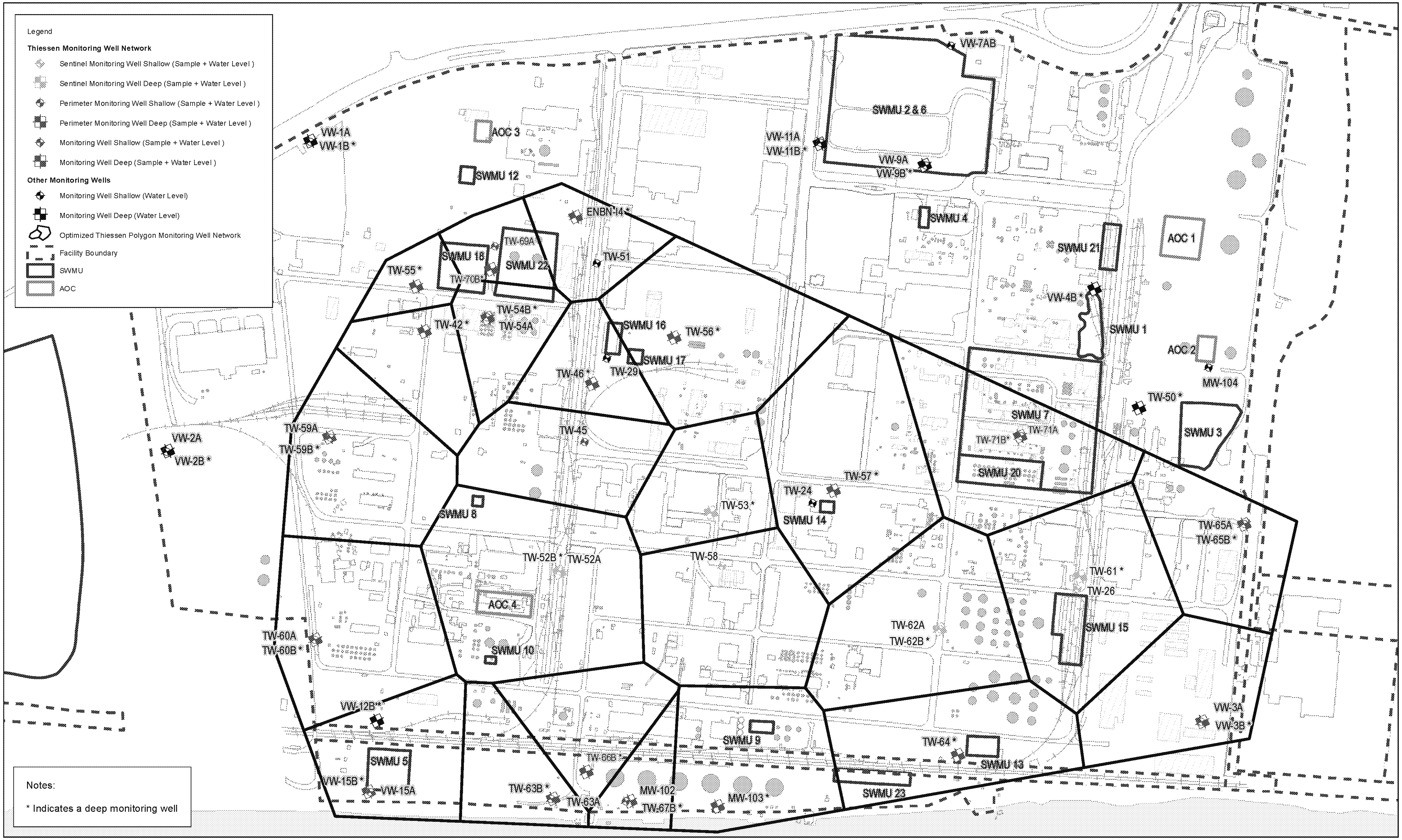

Figure F-1
Thiessen Polygon Network
2015 Groundwater Performance Monitoring Report
Union Carbide Corporation Institute Facility
Institute, West Virginia

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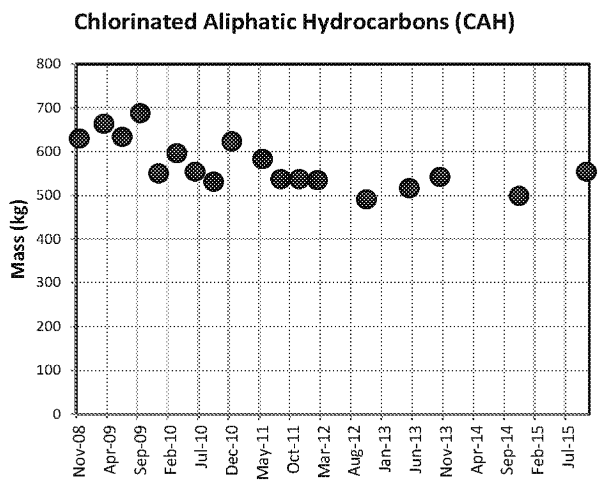
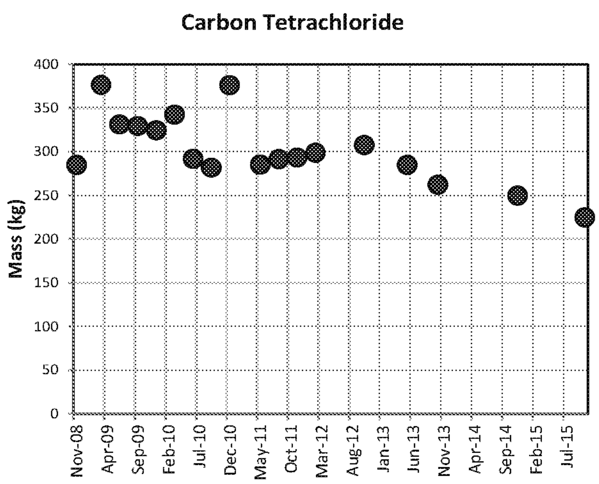
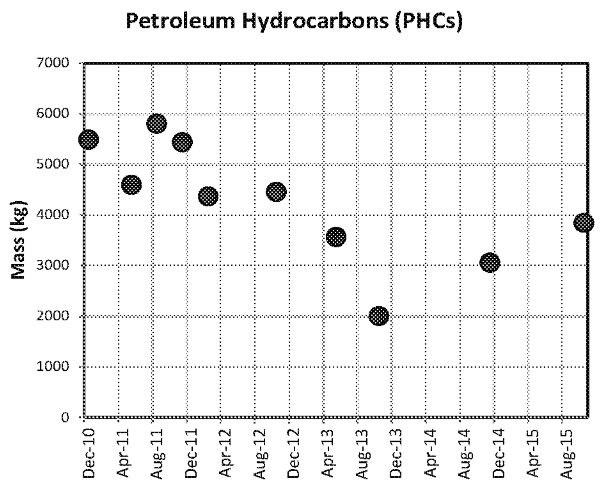
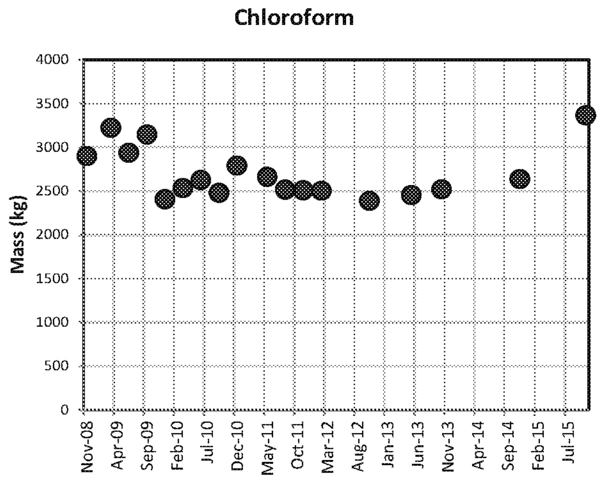
Document Path: E:\GIS\Dow\Institute\Reports\2016\SiteWideGWPerformanceReport2015\MapFiles\Figure F1 - Thiessen Polygon Network.mxd, Date Saved: 3/3/2016 4:13:57 PM, User Name: mpetersh









Notes: 1. *All concentrations in micrograms per liter (μg/L)*
2. *CAHs = Chlorinated Aliphatic Hydrocarbons*
3. *Only wells with increasing or decreasing trends are shown*

FIGURE F-2
COC Groups - Graphs of Mass through Time
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Institute, West Virginia